Calhoun
Institutional Archive of the Naval Postgraduate School

Calhoun: The NPS Institutional Archive
DSpace Repository

Theses and Dissertations 1. Thesis and Dissertation Collection, all items

1986

A trade-off study of tilt rotor aircraft versus helicopters using VASCOMP II and HESCOMP.

Walsh, Thomas P.

http://hdl.handle.net/10945/22155

Downloaded from NPS Archive: Calhoun

DUDLEY KNOX LIBRARY

Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

http://www.nps.edu/library

DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA 93943

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A TRADE-OFF STUDY OF TILT ROTOR AIRCRAFT VERSUS HELICOPTERS USING VASCOMP II AND HESCOMP

by

Thomas P. Walsh

March 1986

Thesis Advisor: Max F. Platzer

Approved for public release; distribution is unlimited

T227877

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION

1b. RESTRICTIVE MARKINGS

2a. SECURITY CLASSIFICATION AUTHORITY

2b. DECLASSIFICATION / DOWNGRADING SCHEDULE

3 DISTRIBUTION / AVAILABILITY OF REPORT
Approved for public release; distribution is unlimited

4. PERFORMING ORGANIZATION REPORT NUMBER(S)

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION
Naval Postgraduate School

6b. OFFICE SYMBOL *(If applicable)*
Code 67

7a. NAME OF MONITORING ORGANIZATION
Naval Postgraduate School

6c. ADDRESS *(City, State, and ZIP Code)*
Monterey, California 93943-5100

7b. ADDRESS *(City, State, and ZIP Code)*
Monterey, California 93943-5100

8a. NAME OF FUNDING / SPONSORING ORGANIZATION

8b. OFFICE SYMBOL *(If applicable)*

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

8c. ADDRESS *(City, State, and ZIP Code)*

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
A TRADE-OFF STUDY OF TILT ROTOR AIRCRAFT VERSUS HELICOPTERS USING VASCOMP II AND HESCOMP

12. PERSONAL AUTHOR(S)
Walsh, Thomas P.

13a TYPE OF REPORT
Master's Thesis

13b. TIME COVERED
FROM ________ TO ________

14. DATE OF REPORT *(Year, Month, Day)*
1986 March

15 PAGE COUNT
218

16. SUPPLEMENTARY NOTATION

17 COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
VASCOMP
HESCOMP
TILT ROTOR

19 ABSTRACT *(Continue on reverse if necessary and identify by block number)*

Trade-off studies were conducted wherein two versions of tilt rotor aircraft were examined to determine optimum mission distances where the tilt rotor designs were superior to a comparable contemporary (pure) helicopter. Two FORTRAN computer programs (VASCOMP II and HESCOMP) developed under contract for NASA Ames Research Center by the Boeing VERTOL Company were used to predict aircraft performance. Program results were validated using data from independent sources. A simplified user's manual is included (with sample data and program output) for VASCOMP II use at the Naval Postgraduate School, Monterey, California.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION
unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL
Prof. Max F. Platzer

22b. TELEPHONE *(Include Area Code)*
(408) 646-2941

22c. OFFICE SYMBOL
Code 67

83 APR edition may be used until exhausted
All other editions are obsolete.

Approved for public release; distribution is unlimited.

A Trade-Off Study of Tilt Rotor Aircraft versus Helicopters Using VASCOMP II and HESCOMP

by

Thomas P. Walsh
Captain, United States Army
B.S., Norwich University, 1976

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
March, 1986

ABSTRACT

Trade-off studies were conducted wherein two versions of tilt rotor aircraft were examined to determine optimum mission distances where the tilt rotor designs were superior to a comparable contemporary (pure) helicopter. Two FORTRAN computer programs (VASCOMP II and HESCOMP) developed under contract for NASA Ames Research Center by the Boeing VERTOL Company were used to predict aircraft performance. Program results were validated using data from independent sources. A simplified user's manual is included (with sample data and program output) for VASCOMP II use at the Naval Postgraduate School, Monterey, California.

Thesis
N222936
c.1

TABLE OF CONTENTS

I. INTRODUCTION -- 8

II. BACKGROUND -- 10

III. PROBLEM DEFINITION ------------------------------ 17

IV. DESCRIPTION OF AIRCRAFT ------------------------- 19

  A. GENERAL -- 19

  B. BOEING VERTOL MODEL 107 ------------------------ 19

  C. 44-PASSENGER TILT ROTOR ------------------------ 42

  D. 25-PASSENGER TILT ROTOR ------------------------ 61

V. DESCRIPTION OF EXPERIMENTS ---------------------- 82

VI. RESULTS -- 85

VII. DISCUSION AND CONCLUSIONS ---------------------- 98

APPENDIX VASCOMP II USER'S MANUAL -------------------- 101

LIST OF REFERENCES ------------------------------------ 214

BIBLIOGRAPHY -- 215

INITIAL DISTRIBUTION LIST ----------------------------- 217

LIST OF TABLES

1. BOEING VERTOL CH-46F DESCRIPTION -------------------- 20

2. COMPARISON OF ACTUAL CH-46F AND HESCOMP CH-46F ------- 22

3. BELL HELICOPTER TEXTRON 44-PASSENGER TILT ROTOR ------ 42

4. COMPARISON OF BHT AND VASCOMP II 44-PAX TILT ROTOR --- 43

5. BELL/BOEING VERTOL 25-PASSENGER TILT ROTOR ----------- 61

6. COMPARISON OF BELL/BOEING & VASCOMP TILT ROTOR ------- 62

LIST OF FIGURES

1. Fuel Required vs. Range -------------------------------- 86
2. Time Required vs. Range -------------------------------- 87
3. Pax-Mi/Lb-Fuel vs. Range ------------------------------ 88
4. Loiter Time vs. Mission Radius ----------------------- 90
5. Fuel Required vs. Loiter Time ------------------------ 91
6. Hover Time vs. Mission Radius ------------------------ 92
7. Fuel Required vs. Hover Time ------------------------- 93
8. Fuel Required vs. Range -------------------------------- 95
9. Time Required vs. Range -------------------------------- 96
10. Pax-Mi/Lb-Fuel vs. Range ----------------------------- 97

ACKNOWLEDGEMENT

I wish to acknowledge the extensive assistance provided by Mr. Dennis Mar of the W.R. Church Computer Center. His technical expertise and his competence in sharing his knowledge in the areas of Multiple Virtual System procedures and magnetic tape usage at NPS proved invaluable during the conversion of VASCOMP II and HESCOMP from CDC FORTRAN to VS FORTRAN.

Sincere thanks to Professor M. F. Platzer for his support and guidance during the completion of the thesis research.

My appreciation is also extended to the many individuals who were excessively cooperative in providing information and material used for this research including: Mr. Tom Galloway, Mr. Cliff McKeithan, and Ms. Donna Diebert, all of NASA Ames Research Center; Mr. Hal Rosenstein of Boeing VERTOL Company; and Mr. Ron Reber of Bell Helicopter TEXTRON.

I. INTRODUCTION

New horizons have been opened for V/STOL aircraft as a result of the NASA/Army XV-15 Tilt Rotor Research Program and its successful demonstration of the tilt rotor concept.

Application of tilt rotor technology lends itself aptly to a myriad of military missions and also has significant potential for future performance in civil roles. It is plausible, for example, that tilt rotor aircraft could replace conventional fixed-wing turboprops and helicopters for both military and civilian missions within optimal range parameters. The limits of these "optimal" range missions can be approximated with the aid of aircraft sizing and performance computer programs.

Past studies [Ref. 1, 2] used computer generated data to make performance comparisons between tilt rotor aircraft designs and comparable contemporary aircraft. The results were then used to assist in evaluating the suitability of the roles selected for the potential tilt rotor designs. This thesis research was conducted using a similar approach. Data was generated for two potential tilt rotor designs using the V/STOL Aircraft Sizing and Performance Computer Program (VASCOMP II). Data was also generated for a contemporary rotary-wing aircraft using the Helicopter Sizing and Performance Computer Program (HESCOMP). Both programs were developed under contract by the Boeing VERTOL Company for the National Aeronautics and Space Administration, Ames Research Center, Moffet Field, California.

VASCOMP II and HESCOMP are intentionally similar in program structure, program data requirements, and program output. This allows comparisons between the results of the two programs.

Application of VASCOMP II is appropriate for predicting sizing and performance data for aircraft that employ fixed wing surfaces to obtain lift in primary cruise flight. Use of HESCOMP is applicable for aircraft that use rotary wing surfaces to obtain lift in forward flight.

II. BACKGROUND

A. NASA/ARMY PROGRAM

In 1972, NASA and the United States Army jointly sponsored the XV-15 Tilt Rotor Research Aircraft Program. The primary objective of the program was to demonstrate that dynamic stability problems, which plagued earlier tilt rotor designs, had been resolved. In 1973, Bell Helicopter TEXTRON won a minimum cost contract to build two flightworthy testbed tilt rotor research aircraft to be used during the flight test portion of this proof-of-concept program. On October 22, 1976, the first of the two prototypes (tail number N702) was rolled out of Bell's Arlington, Texas facility. This aircraft made its first hovering flight on May 3, 1977. It was then used for extensive wind tunnel studies which had to be completed, in accordance with the NASA/Army contract, prior to the release of the second prototype (N703) for full flight testing. The first full in-flight conversion from the helicopter mode to the airplane mode was performed in aircraft N703 on July 24, 1979.

B. XV-15 DESIGN CHARACTERISTICS

The XV-15 is 42 feet long, has a H-tail, and utilizes a slightly forward swept, high-wing that is 32 feet wide. The design incorporates two three-bladed proprotors mounted on wingtip nacelles, each rotor having a diameter of twenty-five (25) feet. Maximum takeoff gross weight for the aircraft is 13,000 lbs in the VTOL mode and 15,000 lbs in the STOL mode. Each wingtip nacelle houses a transmission and a 1550-shp Lycoming T-53 turboshaft engine that is modified (primarily the lubrication systems) for both horizontal and vertical operation. The nacelles, which can rotate through 95 degrees during conversion between helicopter and airplane modes, are positioned vertically for VTOL segments and rotated to the horizontal position, after takeoff, for airplane operations. The nacelles can be rotated five (5) degrees aft of vertical for rapid decelerations in the air, aft translations at a hover, and for providing a responsive means of accelerating and decelerating the aircraft during ground operations. Conversion between the helicopter and airplane mode takes roughly 12-15 seconds and has proven, without exception, to be an uncomplicated, safe, and completely reliable procedure. Rotor RPM is reduced when in the airplane mode to provide greater propulsive efficiency. Maximum airspeed of the aircraft is 301 knots in forward flight, 35 knots in sideward flight, and 25 knots in rearward flight. As is typical with conventional tandem rotor helicopters, the XV-15 is not greatly affected by wind direction during hovering flight.

C. JOINT SERVICES OPERATIONAL TESTING

Military operational testing of the XV-15 began in 1982 to determine the suitability of tilt rotor aircraft to perform select military missions. Testing was conducted over an 18-month period and included US Army evaluations at Fort Huachuca, AZ to study the vulnerability of the aircraft in a ground threat environment; US Navy shipboard and downwash evaluations aboard the USS Tripoli and at Dallas NAS, TX respectively; and USMC mission-oriented flight tests at Yuma Proving Grounds, AZ.

D. JVX

The versatility of the XV-15 quickly convinced a study group that a tilt rotor aircraft could meet future mission requirements of the Army, Navy, Marine Corps, and Air Force. By the end of 1982, the Joint Services Advanced Vertical Lift Aircraft Development Program (JVX) had been formed. Through JVX, the services are attempting to procure approximately 1000 production model tilt rotor aircraft. In April 1983, a contract was awarded to the manufacturing team of Bell Helicopter TEXTRON and Boeing VERTOL to begin preliminary design work on the multimission, multiservice tilt rotor aircraft.

E. BELL-BOEING DESIGN

As a baseline aircraft, preliminary design studies are using the Bell-Boeing Model 901-X. The military designation for the world's first production model tilt rotor V/STOL aircraft is the V-22 OSPREY. It will have a VTOL mission weight of 43,800 pounds, a STOL mission weight of 55,000 pounds, a cruise speed at maximum gross weight of 260 knots, and a service ceiling of over 30,000 feet. When loaded with 24 combat equipped troops, it will have a mission radius of 200 nautical miles and will be able to self-deploy worldwide. Flight controls will incorporate triple-channel fly-by-wire technology and the propulsion system will utilize a 6000 shp engine to be built by a yet-to-be-selected manufacturer. Bell is responsible for the lift/propulsion system to include wing, rotor, nacelle, and transmission. Boeing VERTOL is responsible for everything below the wing to include the all-composite fuselage and tail, the landing gear, and all subsystems. Boeing is also responsible for the aircraft's aerodynamics, performance, and handling qualities. Eight flying prototypes will be built with a "first flight" date scheduled for mid-1987. The first delivery, which will be to the Marine Corps, is currently scheduled for mid-1991.

F. TECHNOLOGY TRANSFER

For numerous reasons, all substantiated during the flight testing of the XV-15, tilt rotor aircraft could be rapidly integrated into the civilian aviation community. Examples of highly desirable features inherent to tilt rotor designs include:

1. High-speed cruise capability
2. Fuel efficiency in the airplane mode
3. Vertical takeoff and landing capability
4. Low noise for passenger comfort/community acceptance
5. Low vibration for passenger comfort/less maintenance

A tilt rotor design for use in the civilian sector can have both national and international impact. It could be particularly beneficial in applications where construction of large airport facilities is either impractical or impossible. For example, there is an abundant number of cases where small communities are dispersed over vast areas supported by a poor ground infrastructure. Alaska, Brazil, Indonesia, Canada, Japan, and the Carribean Basin are prime examples of areas which desperately need a resource with the high productivity potential of a tilt rotor aircraft.

Alaskan dependence on aviation is significantly higher than any other state in the nation. Statistics [Ref. 5] show that Alaska has 16 times more aircraft and 8 times more pilots logging 15 times more flight hours per capita as compared to the rest of the United States. Accessibility to Alaska's natural resources (offshore oil, minerals, timber, fish, etc.) could be greatly enhanced using V/STOL aircraft with the versatility found in tilt rotor designs. As this state's economy grows, the need for additional conventional airports could be greatly reduced or eliminated through use of V/STOL aircraft like the tilt rotor resulting in enormous savings in construction costs. Also, expenses associated with the removal of snow and ice from long runways (75% of expenditures at community airports is allocated to this) could be substantially reduced. Canada and Japan, in many ways, have conditions similar to those found in Alaska.

Brazil, Indonesia, and the Carribean are examples of developing nations that could greatly enhance their efforts towards economic advancement through use of V/STOL aircraft which would permit industrial and agricultural growth without the necessity of having to build railroads, harbors, and/or airports to support expansion operations.

G. MISSION POTENTIAL

The VTOL capability of a tilt rotor aircraft coupled with its capacity for high cruise speeds makes it a fierce competitor for missions currently performed by conventional helicopters. Some of the military and civilian applications include:

1. Troop transport
2. Search and rescue
3. Reconnaissance/surveillance
4. Law enforcement
5. Medical evacuation
6. Public transportation
7. Corporate/executive transport
8. Offshore oil exploration and production

H. EXCESSIVE INITIAL COST

Although tilt rotor aircraft have advantages which may never be matched by conventional helicopters, it is not expected that rotary-wing aircraft will become totally obsolete. There are various parameters which, depending on their value, could make use of helicopters more feasible than use of tilt rotor aircraft. One such parameter is cost. Any new aircraft design necessitates a development program which translates to high monetary expenditures. This fact could make acquisition of tilt rotor aircraft "cost prohibitive" to users requiring only a small quantity of aircraft, say, five or less. The percentage of businesses in the civilian market that would fit into this category is large enough to prevent a civilian development program until after the completion of a comparable military development program. The danger of postponing a civilian program is that, in doing so, the United States may very well lose its competitive edge and allow foreign competitors to seize the initiative and capture the international market that is beginning to form for tilt rotor designs. The Soviet Union and France are currently working on their own tilt rotor aircraft. For an example of lost opportunities one has only to look as far as the Quiet Short-Haul Research Aircraft (QSRA) which underwent extensive study and development at NASA Ames Research Center, Moffett Field, California. This design was noted to have significant potential as a STOL transport but the lack of a military development program stalled the design at the research prototype stage. Recently, Japan announced the successful maiden flight of a commercial STOL aircraft, soon to be made available on the international market, which has an uncanny resemblance to the NASA Ames QSRA.

III. PROBLEM DEFINITION

A. GENERAL

Perhaps the most difficult decision that will face a potential user of tilt rotor technology is whether or not the vastly increased productivity available through tilt rotor aircraft designs justifies the substantially higher costs of initial acquisition. Clearly, features that would qualify a transport aircraft as "successful" include:

1. Low noise
2. Long range
3. Low vibration
4. High performance
5. Low operating costs
6. Low fuel consumption

Additionally, parameters such as the cost of acquiring real estate and the escalating costs of construction (for new airports), aggravation of air traffic congestion at existing airports, and the importance of time to the traveller, will play a major role in the decision making process of civilian communities, businesses, and individuals who might be considering the utilization of tilt rotor aircraft for their their aviation transportation requirements.

Trade-off studies provide a low risk, relatively low cost method of analyzing available options during any selection process. In the case of judging the suitability of a new aircraft design, computer programs, used for predicting sizing and performance parameters, have become a vital tool used in the early stages of design work.

B. RESEARCH GOAL

The objective of this research was to make comparisons between the performance of a Boeing VERTOL Model 107 tandem rotor helicopter (military designation: CH-46F SEA KNIGHT) and the performance of comparable tilt rotor aircraft. Specifically, it was desired to use sizing and performance computer programs to predict values of "range" which would show the superiority of one aircraft type over the other.

C. RESEARCH PARAMETERS

Parameters considered during this research included:

1. Fuel required versus distance
2. Time required versus distance
3. Passenger mile per pound of fuel versus distance

IV. DESCRIPTION OF AIRCRAFT

A. GENERAL

The aircraft studied during this thesis research project included the following:

1. Boeing VERTOL Model 107
2. 44-Passenger Tilt Rotor
3. 25-Passenger Tilt Rotor

All three aircraft are described in this chapter and the results of calibration runs are discussed. It should be noted that these particular aircraft were not selected for reasons related to their size or performance capabilities. Selection was based solely on the fact that these were the aircraft for which the greatest quantity of descriptive information was obtained during the period of research.

B. BOEING VERTOL MODEL 107

1. Description

There are numerous versions of this Boeing VERTOL product that first flew in 1958. The Model 107 II is the standard commercial version equipped with two 1,250 shp General Electric CT58 turboshaft engines. The military version of this aircraft is the CH/UH-46 SEA KNIGHT. There are several variations to the basic CH-46 to include the CH-46A, CH-46D, and the CH-46F. Typical differences between versions include uprated power plants, additional electronic equipment, and cambered rotor blades. The CH-46F was used for all experiments discussed in this thesis. Reference 6 was used to obtain some of the more noteworthy specifications of the aircraft as shown below in Table 1.

TABLE 1

BOEING VERTOL CH-46F DESCRIPTION

Type:	Twin-engined, transport helicopter
Engines:	Two 1400 shp General Electric T58 shaft-turbines
Rotors:	Two three-bladed rotors in tandem
Dimensions:	
Diameter of main rotors:	51 ft 0 in
Length overall, blades turning:	84 ft 4 in
Length of fuselage:	44 ft 10 in
Main rotor blade area:	39.85 sq ft
Main rotor disc area:	4,086 sq ft
Weights and Loadings:	
Weight empty, equipped:	13,342 lb
Max takeoff and landing weight:	23,000 lb
Max disc loading:	5.63 psf
Performance:	
Max permissable speed:	144 knots
Max cruising speed:	143 knots
Service ceiling:	14,000 ft
Ranges (with 10% reserve fuel):	
At 20,800 lb (4,275 lb payload):	206 naut mi
At 23,000 lb (6,475 lb payload):	198 naut mi
Fuel Capacity:	
Standard configuration:	380 US gal
Accommodation:	
Crew:	3
Passengers:	25

2. Aircraft Calibration Using HESCOMP

Data for the CH-46F was obtained from NASA Ames Research Center. To insure the validity of results obtained using HESCOMP, calibration runs were made to match computer generated results with descriptive data from Table 1 above. There were several key parameters to be considered during the experiments including: fuel, time, power, distance, and airspeed. As such, emphasis was placed on calibrating the items that would affect these key parameters. For example, to match the aircraft description in Table 1, the HESCOMP results had to depict an aircraft that could carry a payload of 4275 pounds for a distance of 206 nautical miles and, in so doing, use all available fuel except for a 10% reserve. Calibration was accomplished using the flexibility built into HESCOMP. Many data locations are established to describe a component's weight or performance, as applicable. Some of the data locations represent constants and some represent multiplicative factors. Data can be input based on actual values or the user can use the program, in some cases, to calculate approximate values. The values of component weights, for example, can be input based on known data or the program can calculate them based on weight trends of other aircraft in the same weight class. For the CH-46F, when the empty weight did not match data from Reference 6, the "Body Group Weight Factor" (location 2622), which varies the fuselage weight, was manipulated until the desired empty weight was obtained. After consideration of the parameters being analyzed, it was not felt that this "fudge factor" would have any impact on the results. This flexibility allows for convenient and very precise control of many of the parameters in the program. As can be noted below in Table 2, the calibrated aircraft description used for HESCOMP very nearly matches the performance specifications of the actual aircraft as described in reference 6.

TABLE 2

COMPARISON OF ACTUAL CH-46F AND HESCOMP CH-46F

	ACTUAL	HESCOMP	% DIFFERENCE
Dimensions:			
Main rotor diameter:	51.000 ft	50.966 ft	0.067
Length overall:	84.333 ft	83.900 ft	0.513
Fuselage length:	44.833 ft	43.700 ft	2.528
Weights and Loading:			
Weight empty:	13,342 lb	13,342 lb	0.000
Operating weight:	14,055 lb	14,055 lb	0.000
Payload:	6,475 lb	6,475 lb	0.000
Fuel:	2,550 lb	2,550 lb	0.000
Gross weight:	23,000 lb	23,000 lb	0.000
Disc loading:	5.629 psf	5.637 psf	0.134
Ranges (normal power):			
At 20,800 lb:	206 nm	206 nm	0.000
At 23,000 lb:	198 nm	198 nm	0.000

3. Program Data

The program output that was generated by HESCOMP for the CH-46F calibration run is shown below on pages 23 - 41. Pages 23 - 26 show the "echo" of the input data file. Mission performance data begins on page 34. It can be seen that two missions were flown. The first mission was flown at the aircraft's maximum gross weight of 23,000 pounds. This was done to insure that the aircraft was sized properly by the program. The payload was reduced for the second mission which was flown at a gross weight of 20,800 pounds. The aircraft's maximum range (at normal power setting) was calibrated for this weight.

```
DATE 11/25/85   CH-46F    NASA AMES CALIBRATION                        PAGE  1

                               H E S C O M P

                HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    B-91

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE
"LOC. " = LOCATION NUMBER GIVEN ON INPUT SHEET
"NUM  " = NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC.  (MAX = 5)
"VAL  " = VALUE FOR VARIABLE CORRESPONDING TO LOC.
"VAL1" = VALUE FOR VARIABLE CORRESPONDING TO LOC. +0001
"VAL2" = VALUE FOR VARIABLE CORRESPONDING TO LOC. +0002
 ETC.

   NOTE:   IN USING AUXILIARY ENGINES; AUXILIARY ENGINE CYCLE INPUT
           LOCATIONS CAN BE CREATED BY PLACING A 666666 CARD IN FRONT AND
           BEHIND A STANDARD ENGINE CYCLE

LOC.  NUM       VAL          VAL1          VAL2          VAL3          VAL4

   1   5      1.000       0.0000E+00      1.000         1.000         2.000
   6   4      1.000        4.000        0.0000E+00      1.000
  20   3      2.000        2.000          1.000
  23   5     0.2300E+05   0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00
  28   5     0.3200        200.0          200.0         3.000         1.000
  33   2      255.0        1.390
 122   5      7.170        7.250         0.6250         1.625         27.50
 127   1      8.000
 132   1     0.3480
 142   4     0.3500E-01    2.000        0.7800E-01    0.0000E+00
 152   5     0.4500       0.2500        0.3400        0.6300         3.450
 157   4     0.5000       0.3000        0.6100        0.6900
 162   1     0.1400
 176   5      3.000       -9.000        0.2000        0.7500E-01    0.1200
 171   3      2.000        2.000         5.637
 181   5      707.0       0.1200         1.080         143.0        0.0000E+00
 186   5     0.0000E+00   0.9500E-01     2.000         1.500         1.000
 191   2      1.530       0.0000E+00
 193   3     0.8500       0.7500        0.0000E+00
 195   1     0.0000E+00
 217   5      1.761        2800.          2.000         2.000         1.000
 223   2     0.9700        20.00
 227   5     0.1400E+05    1.000        0.0000E+00     1.105        0.0000E+00
```

```
  232  5      1.000        0.0000E+00     2.000        0.0000E+00     143.0
  237  2     0.0000E+00     1.105
  303  4     0.6000E-02    0.1500        0.7500         1.400
  309  1     0.3200E-02
  316  1      14.00
  319  3      1.050         1.250         1.300
  323  1      3.000
  326  3      1.800        0.0000E+00    0.1490E+07
  104  1      1.000
 2602  3      3051.         633.0         6475.
 2613  5      26.00         22.55         34.55        0.0000E+00    0.0000E+00
 2618  5     0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00     106.9
 2623  5      3.000        0.2840E-01    0.8000        0.0000E+00    0.0000E+00
 2628  5     0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00
 2633  5      71.00        0.0000E+00    0.0000E+00    0.0000E+00     41.14
 2638  5      1.000         66.38         1.000         1.250        0.0000E+00
 2643  5     0.0000E+00    0.0000E+00    0.0000E+00     289.4         4.000
 2648  5     0.0000E+00    0.0000E+00    0.0000E+00    0.1120         187.0
 2653  1     0.0000E+00
 2659  1      1.000
  347  5      3.000         3.000        0.0000E+00    0.5000         1.000
  354  3     0.0000E+00    0.5000         1.000
  361  3      1.000         1.000         1.000
  368  3      1.000         1.000         1.000
  375  3      1.000         1.000         1.000
 1201  5     0.0000E+00    0.0000E+00    0.0000E+00     2.000        0.0000E+00
 1206  1     0.0000E+00
 1223  1     0.9050
 1301  5      1.761        0.2730        0.0000E+00    0.3200E-01     950.0
 1306  5      1100.         1856.         2000.         2000.         8.000
 1311  5      950.0         1200.         1400.         1600.         1800.
 1316  5      2000.         2200.         2600.         5.000        0.0000E+00
 1321  4     0.2000        0.4000        0.6000        0.8000
 1326  5     0.2500E-01    0.2570E-01    0.2780E-01    0.3130E-01    0.3620E-01
 1332  5     0.1630        0.1676        0.1813        0.2041        0.2360
 1338  5     0.3350        0.3444        0.3725        0.4194        0.4851
 1344  5     0.5440        0.5592        0.6049        0.6811        0.7877
 1350  5     0.7700        0.7916        0.8562        0.9640         1.115
 1356  5      1.000         1.028         1.112         1.252         1.448
 1362  5      1.200         1.234         1.334         1.502         1.738
 1368  5      1.550         1.593         1.724         1.941         2.244
 1374  5      8.000         950.0         1200.         1400.         1600.
 1379  5      1800.         2000.         2200.         2600.         5.000
 1384  5     0.0000E+00    0.2000        0.4000        0.6000        0.8000
 1390  5     0.6500E-01    0.6510E-01    0.6530E-01    0.6700E-01    0.7100E-01
 1396  5     0.1150        0.1160        0.1180        0.1280        0.1400
 1402  5     0.1800        0.1810        0.1900        0.2080        0.2270
 1408  5     0.2600        0.2610        0.2730        0.2950        0.3250
```

```
1414  5    0.3420       0.3470       0.3620       0.3890       0.4250
1420  5    0.4250       0.4350       0.4510       0.4860       0.5170
1426  5    0.5000       0.5110       0.5300       0.5600       0.6100
1432  5    0.6260       0.6310       0.6600       0.7180       0.7800
1438  4     3.000        950.0        1600.        2600.
1447  4     3.000      0.0000E+00   0.4000       0.8000
1454  3    0.2600       0.2710       0.2900
1460  3    0.8200       0.8400       0.9000
1466  3     1.090        1.118        1.165
1502  5     8.000        950.0        1200.        1400.        1600.
1507  5     1800.        2000.        2200.        2600.        5.000
1512  5    0.0000E+00   0.2000       0.4000       0.6000       0.8000
1518  5    0.2600       0.2650       0.2710       0.2800       0.2900
1524  5    0.5200       0.5270       0.5400       0.5600       0.5900
1530  5    0.6800       0.6900       0.7050       0.7300       0.7600
1536  5    0.8200       0.8240       0.8400       0.8680       0.9000
1542  5    0.9200       0.9300       0.9500       0.9800        1.020
1548  5     1.000        1.002        1.020        1.050        1.090
1554  5     1.052        1.055        1.070        1.100        1.131
1560  5     1.090        1.100        1.118        1.135        1.165
1601  2     2.000       -9.000
1603  5    0.1155E-01 -0.5740E-01   0.4150       0.6410        1.393
1608  1    0.7250
1609  5    0.1100E-01    18.30      0.1375       0.2000       0.8500E-02
1614  2     2.400       0.8200
1616  5     10.00      0.0000E+00   0.4000E-02   0.7000E-02   0.9000E-02
1621  5    0.1000E-01   0.1100E-01   0.1150E-01   0.1200E-01   0.1550E-01
1626  5    0.2200E-01    1.018        1.085        1.154        1.233
1631  5     1.279        1.314        1.327        1.337        1.364
1636  1     1.397

     FLIGHT MISSION PROFILE

  35  5     1.000        2.000        3.000        4.000        5.000
  40  5     2.000        1.000      0.0000E+00     8.000        1.000
  45  5     2.000        3.000        4.000        5.000        2.000
  50  2     1.000        100.0
 401  4    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 411  4    0.2500E-01   0.2500E-01   0.2500E-01   0.2500E-01
 441  4     1.105        1.105        1.105        1.105
 461  4     2.000        2.000        2.000        2.000
 481  4    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 491  5     1.000        1.000        1.000        1.000      0.0000E+00
 511  4    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 531  4    0.1667E-01   0.1667E-01   0.1667E-01   0.1667E-01
 541  4     1.105        1.105        1.105        1.105
 551  4    0.1667E-01   0.1667E-01   0.1667E-01   0.1667E-01
 571  2     1.000        1.000
 591  2      0.0000E+00    0.0000E+00
 621  2       1000.         1000.
 631  2      0.0000E+00     1.000
 641  2       5000.         5000.
 651  2       1.105         1.105
 661  2      0.0000E+00    0.0000E+00
 681  2      0.0000E+00    0.0000E+00
 721  2       1.000         1.000
 741  2      0.0000E+00    0.0000E+00
 771  2       25.00         25.00
 781  2       2.000         2.000
 791  2       198.0         206.0
 801  2       1.081         1.105
 811  2      0.0000E+00    0.0000E+00
 831  2      0.0000E+00    0.0000E+00
 871  2       1.000         1.000
 881  2       120.0         120.0
 891  2      0.0000E+00    0.0000E+00
 911  2      0.0000E+00    0.0000E+00
 921  2       1000.         1000.
 941  2      0.0000E+00    0.0000E+00
 951  2       500.0         500.0
 961  2       198.0         206.0
 971  2       1.105         1.105
 981  2      0.0000E+00    0.0000E+00
1161  1      -2200.
1171  1      0.3330E-01
   3  1       2.000
 312  2       625.0        0.5420

   MODIFICATIONS

2581  3       1.000        0.0000E+00     2.995
2600  1      0.1500E-01
  85  3      0.0000E+00    0.8000E-01     1977.
  88  3       100.0         1.000        0.1000E+06
  91  2       10.00        0.0000E+00
 100  1       1.000
```

```
DATE 11/25/85  CH-46F   NASA AMES CALIBRATION                         PAGE  2

                                 H E S C O M P
            HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

       TANDEM ROTOR - PURE HELICOPTER


S I Z E   D A T A     THIS RUN CONVERGED IN  1 ITERATION(S)
                        GROSS WEIGHT =  23000.  LB
FUSELAGE
        LF             LENGTH                              43.7 FT.
        LC             CABIN LENGTH                        27.5 FT.
        DELTAX1        FWD. ROTOR LOCATION                  7.2 FT.
        DELTAX2        AFT ROTOR LOCATION                   3.6 FT.
        WF             WIDTH                                7.3 FT.
        G/S            ROTOR GAP/STAGGER RATIO              0.140
        (O/L/D)        ROTOR OVERLAP/DIAMETER RATIO         0.348
        SF             WETTED AREA                        881.2 SQ. FT.
    OVERALL OPERATING LENGTH                               83.9 FT.
    WING - NO WING USED
    FORWARD ROTOR PYLON
        AR             ASPECT RATIO                         0.340
        SFP            WETTED AREA                         77.8 SQ. FT.
        FAFP           FRONTAL AREA                        13.0 SQ. FT.
        HP1            HEIGHT                               3.4 FT.
        CBARFP         MEAN CHORD                          10.1 FT.
        LAMBDA FP      TAPER RATIO                          0.630
        (T/C)R         ROOT THICKNESS/CHORD                 0.450
        (T/C)T         TIP THICKNESS/CHORD                  0.250
    AFT ROTOR PYLON
        AR             ASPECT RATIO                         0.610
        SAP            WETTED AREA                        242.6 SQ. FT.
        HP2            HEIGHT                               8.1 FT.
        CBARAP         MEAN CHORD                          13.2 FT.
        LAMBDA AP      TAPER RATIO                                 0.690
        (T/C)R         ROOT THICKNESS/CHORD                        0.500
        (T/C)T         TIP THICKNESS/CHORD                         0.300

     PRIMARY ENGINE NACELLE

        LN             LENGTH                                      4.9 FT.
        DN             MEAN DIAMETER                               1.3 FT.
        SN             WETTED AREA (TOTAL-ALL ENGINES)            40.5 SQ. FT.

     AUXILIARY INDEPENDENT ENGINE NACELLE - NO AUXILIARY INDEPENDENT ENGINE USED

     PROPELLER (AUXILIARY PROPULSION)     - NO PROPELLER USED

   MAIN ROTOR

     DMR            DIAMETER                      51.0 FT.
     SIGMR          SOLIDITY                       0.075
     WG/A           DISC LOADING                   5.6LB/SQ FT
     CT/SIGMA       THRUST COEFF/SOLIDITY          0.095
     NR             NO. OF ROTORS                  2.
     NO. BLADES     NO. OF BLADES/ROTOR            3.
     THETA          BLADE TWIST                   -9.000 DEG.
     XC             BLADE CUTOUT/RADIUS RATIO      0.200
     VTIP           TIP SPEED                    707. FT/SEC
```

```
DATE 11/25/85  CH-46F   NASA AMES CALIBRATION                         PAGE  3

                                  H E S C O M P

                HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

             FIXED EQUIP GROUP                    FIXED USEFUL LOAD
   WAPU                    157.00          WCREW ( 3. )          509.15
   WINSTR                  125.27          WSTU  ( 0. )            0.00
   WHYD                    118.47          WCBAG                  29.95
   WELEC                   455.01          WUF                    38.25
   WAV                     545.00          WOIL                   56.00
   WFUR                    845.29          WSRV                    0.00
   WAC                       0.00          WH20                    0.00
   WAI                     391.00          WEMER                   0.00
   WAUXG                   184.00          WCATER                  0.00

   WFE                    2821.03          WFUL                  633.35
```

```
 DATE 11/25/85  CH-46F   NASA AMES CALIBRATION                         PAGE  4

                                H E S C O M P

            HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91


W E I G H T S    D A T A    IN LBS

  MLF            MANEUVER LOAD FACTOR         3.000
  ULF            ULTIMATE LOAD FACTOR         4.500                   WEIGHT
                                                                      FACTORS
PROPULSION GROUP                                                    -----------
  WPRG     TOTAL MAIN ROTOR GROUP                      2638.
  WPRB            MAIN ROTOR BLADE (PER ROTOR)               555.    K12=  1.000
  WPH             MAIN ROTOR HUB (PER ROTOR)                 500.    K13=  1.000
  WBF             BLADE FOLDING (PER ROTOR)                  264.
  WAR      AUXILIARY PROPULSION ROTOR GROUP               0.         K15=  1.000
  WDS      DRIVE  SYSTEM                               2387.
  WPDS            MAIN ROTOR DRIVE SYSTEM                   2387.    K16=  1.000
  WTRDS           TAIL ROTOR DRIVE SYSTEM                     0.     K20=  1.000
  WADS            AUXILIARY PROPULSION DRIVE SYSTEM           0.     K17=  1.000
  WEP      PRIMARY ENGINES                              764.         K18=  1.000
  WEA      AUXILIARY ENGINES                              0.         K19=  1.000
  WPEI     PRIMARY ENGINE INSTALLATION                  187.
  WAEI     AUXILIARY ENGINE INSTALLATION                  0.
  WFS      FUEL SYSTEM                                  286.
  DEL WP   PROPULSION GROUP WEIGHT INCREMENT              0.
      WP   TOTAL PROPULSION GROUP WEIGHT                       6261.

STRUCTURES GROUP
  WW       WING                                           0.         K 8=  1.000
  WTG      TAIL GROUP                                     0.
  WHT             HOR. TAIL                                   0.     K 9=  1.000
  WTR             TAIL ROTOR                                  0.     K14=  1.000
  WB       FUSELAGE (INCL'S ROTOR PYLON & VTAIL)       2571.         K 6=  1.000
                    (BASED ON SWET BODY =  881. )
                    (        SWET PYLON =   78. )
                    (      SWET VT.TAIL =    0. )
  WLG      LANDING GEAR                                 653.         K 7=  1.000
  WNG             NOSE GEAR                                  131.
  WMG             MAIN GEAR                                  523.
  WTES     TOTAL ENGINE SECTION                          71.
  WPES            PRIMARY ENGINE SECTION                      71.
  WAES            AUXILIARY ENGINE SECTION                    0.
  DEL WST  STRUCTURE WEIGHT INCREMENT                     0.
  WST      TOTAL STRUCTURE WEIGHT                                   3295.

FLIGHT CONTROLS GROUP
  WPFC     PRIMARY FLIGHT CONTROLS                             965.
  WCC            COCKPIT CONTROLS                                   94.
  WRC            MAIN ROTOR CONTROLS                               423.     K 1=  1.000
  WSC            MAIN ROTOR SYSTEMS CONTROLS                       448.     K 2=  1.000
  WFW            FIXED WING CONTROLS                                 0.     K 3=  1.000
  WTM            TILT MECHANISM                                      0.
  WSAS           SAS                                                 0.
  WAFC     AUXILIARY FLIGHT CONTROLS                             0.
  WRCA           AUX. PROPULSION ROTOR CONTROLS                      0.     K 4=  1.000
  WSCA           AUX. PROPULSION ROTOR SYS. CONTROLS                 0.     K 5=  1.000
  WMC            MISCELLANEOUS CONTROLS                              0.
  DEL WFC  CONTROL WEIGHT INCREMENT                              0.
      WFC  TOTAL CONTROL WEIGHT                                      965.

    WFE             WEIGHT OF FIXED EQUIPMENT                           2821.

    WE              WEIGHT EMPTY                                       13342.

    WFUL            FIXED USEFUL LOAD                                    633.

    OWE             OPERATING WEIGHT EMPTY                             13975.

    WPL             PAYLOAD                                             6475.

    (WF)A           FUEL                                                2550.

    WG              GROSS WEIGHT                                       23000.
```

```
DATE 11/25/85  CH-46F   NASA AMES CALIBRATION                       PAGE  5

                                 H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91


R O T O R   D A T A

        ROTOR CYCLE NO.     2.0000

        MAIN ROTOR SOLIDITY SIZED BY MANUEVER CONDITIONS

        H =      0.0 FT.,    TEMP =  59.0 DEG.,    V =  143.0 KTS

        100.0 PERCENT HOVER RPM
        ROTOR MANUEVER G*S =  1.500, CT/SIGMA = 0.095
DATE 11/25/85  CH-46F   NASA AMES CALIBRATION                       PAGE  6

                                 H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91


P R O P U L S I O N   D A T A

   PRIMARY PROPULSION CYCLE NO.    1.761
      TURBOSHAFT ENGINE

      2. ENGINES

      BHP*P    MAX. STANDARD S.L. STATIC H.P.     2800.  H.P.

      ENGINE SIZE WAS FIXED BY INPUT

      MAIN ROTOR DRIVE SYSTEM RATING            2800.  H.P.

   XMSN SIZED AT 100. PERCENT OF MAIN ROTOR HOVER POWER REQUIRED
   AT H =14000. FT, TEMP =  9.08 DEG.F.,   0.0 PERCENT HOVER RPM
```

```
DATE 11/25/85  CH-46F   NASA AMES CALIBRATION                        PAGE  7

                        H E S C O M P

            HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91


A E R O D Y N A M I C S   D A T A
   FE            TOTAL EFFECTIVE FLATPLATE AREA                 36.800 SQ FT
   SWET          TOTAL WETTED AREA                            1242.     SQ FT
   CBARF         MEAN SKIN FRICTION COEFF.                       0.029626

D R A G   B R E A K D O W N   IN  SQ FT
   FEW           WING FE                                         0.000
   FEF           FUSELAGE FE                                    36.800
   FEFP          FORWARD(MAIN) ROTOR PYLON FE                    0.000
   FEAP          AFT ROTOR PYLON FE                              0.000
   FEMRH         MAIN ROTOR HUB(S) FE                            0.000
   FETRH         TAIL ROTOR HUB FE                               0.000
   FEVT          VERTICAL TAIL FE                                0.000
   FEHT          HORIZONTAL TAIL FE                              0.000
   FEN           PRIMARY ENGINE NACELLE FE                       0.000
   FENI          AUX. INDEPENDENT CRUISE ENG. NAC. FE            0.000
   FENS          AUX. INDPENDENT CRUISE ENG. STRUT FE            0.000
   DELTA FE      INCREMENTAL FE                                  0.000

A E R O D Y N A M I C   C O E F F I C I E N T
   A5                                                           36.79999
   A6                                                            0.00000
   A7                                                            0.00000
   A8                                                            0.00000
   A9                                                            0.00000
   E        WING LIFT EFFICIENCY FACTOR                          0.00000
   EVT      VERTICAL TAIL LIFT EFFICIENCY FACTOR                 0.00000
```

```
 DATE 11/25/85  CH-46F   NASA AMES CALIBRATION                       PAGE  8

                                H E S C O M P
                 HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91


                          MISSION PERFORMANCE DATA

TAXI  FOR  0.025  HRS. AT GROUND IDLE ENGINE RATING
                                     PRIM   PRIM   TOT   AUX   AUX   AUX
            FUEL          PRES       TURB   ENG    FUEL  TURB  ENG   FUEL TEMP
TIME   RNG  USED  WEIGHT  ALT   TAS  TEMP   PEHF   FLOW  TEMP  PEHF  FLOW  DEG
(HRS)  (NM) (LB)   (LB)  (FT)  (KT) (R)         (LB/HR) (R)        (LB/HR) (F)
0.000    0.0    0.  23000.     0.    0.   950. 0.000   253.  ---   ---   ---    59.0
0.025    0.0    6.  22994.     0.    0.   950. 0.000   253.  ---   ---   ---    59.0
TAKEOFF, HOVER, OR LAND AT PETF = 1.000 FOR  0.017 HRS.
                                     PRIM   PRIM   TOT   THRUST
            FUEL          PRES       TURB   ENG    FUEL    TO
TIME  RNG   USED  WEIGHT  ALT   TAS  TEMP   PEHF   FLOW  WEIGHT   FM  BHP    CT
(HRS) (NM)  (LB)   (LB)  (FT)  (KT) (R)         (LB/HR)
0.025    0.0    6.  22994.     0.    0.  2000. 1.000  1654.  1.111  .63 2793. .0053
0.042    0.0   34.  22966.     0.    0.  2000. 1.000  1654.  1.111  .63 2788. .0053
CLIMB  TO  5000.  FT. WITH   MAXIMUM R/C  AT  MAXIMUM  ENGINE RATING
** TAS (AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED
                                     PRIM PRM PRIM       CT'
            FUEL          PRES       TURB ENG ENG       OVER  ALFA
TIME  RNG   USED  WEIGHT  ALT   TAS  TEMP CDE PEHF   MU SIGMA D/L   BHP   R/C
(HRS) (NM)  (LB)   (LB)  (FT)  (KT) (R)                     (DEG)       (FPM)
0.042    0.0   34.  22966.     0.   71.  2000.  T   1.000 .17 0.063 -1.6  2823. 1181.
0.056    1.0   58.  22942.  1000.   72.  2000.  T   1.000 .18 0.065 -1.6  2753. 1098.
0.071    2.1   82.  22918.  2000.   73.  2000.  T   1.000 .18 0.067 -1.6  2684. 1015.
0.087    3.4  108.  22892.  3000.   74.  2000.  T   1.000 .18 0.069 -1.6  2616.  932.
0.105    4.7  136.  22864.  4000.   75.  2000.  T   1.000 .18 0.071 -1.6  2548.  848.
0.125    6.2  165.  22835.  5000.   76.  2000.  T   1.000 .18 0.073 -1.6  2481.  763.
```

```
      CRUISE AT   NORMAL   ENGINE RATING

                                           PRIM PRM PRIM        CT'
             FUEL               PRES       TURB ENG ENG         OVER  ALFA          SPEC
TIME   RNG   USED    WEIGHT     ALT   TAS  TEMP CDE PEHF     MU SIGMA D/L    BHP    RNG
(HRS) (NM)   (LB)     (LB)     (FT)  (KT)  (R)                        (DEG)         (NMPP)
0.125    6.2  165.  22835.    5000.  112.  1856.  T  0.852 .27 0.076 -3.4 2155.  0.0882
0.347   31.2  449.  22551.    5000.  113.  1856.  T  0.852 .28 0.075 -3.5 2153.  0.0889
0.568   56.2  730.  22270.    5000.  114.  1856.  T  0.852 .28 0.074 -3.6 2151.  0.0896
0.787   81.2 1009.  21991.    5000.  115.  1856.  T  0.852 .28 0.073 -3.7 2150.  0.0903
1.004  106.2 1286.  21714.    5000.  116.  1856.  T  0.852 .28 0.072 -3.8 2149.  0.0909
1.219  131.2 1561.  21439.    5000.  117.  1856.  T  0.852 .29 0.072 -3.9 2148.  0.0916
1.433  156.2 1834.  21166.    5000.  118.  1856.  T  0.852 .29 0.071 -4.0 2147.  0.0922
1.618  178.0 2070.  20930.    5000.  118.  1856.  T  0.852 .29 0.070 -4.1 2147.  0.0927

DESCEND TO H =     0. FT.  ,R =   198.00 N.MI. AT CONSTANT TAS

                                           PRIM PRM PRIM        CT '
             FUEL               PRES       TURB ENG ENG         OVER  ALFA
TIME   RNG   USED    WEIGHT     ALT   TAS  TEMP CDE PEHF     MU SIGMA D/L     BHP     R/S
(HRS) (NM)   (LB)     (LB)     (FT)  (KT)  (R)                        (DEG)          (FPM)
1.618  178.0 2070.  20930.    5000.  120.  1767.  P  0.747 .29 0.067 -1.9   1880.    500.
1.652  182.0 2108.  20892.    4000.  120.  1767.  P  0.747 .29 0.067 -1.9   1878.    500.
1.685  186.0 2147.  20853.    3000.  120.  1766.  P  0.746 .29 0.067 -1.9   1876.    500.
1.718  190.0 2185.  20815.    2000.  120.  1765.  P  0.745 .29 0.066 -1.9   1874.    500.
1.752  194.0 2223.  20777.    1000.  120.  1765.  P  0.744 .29 0.066 -1.9   1872.    500.
1.785  198.0 2261.  20739.       0.  120.  1764.  P  0.744 .29 0.066 -1.9   1870.    500.

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 FOR  0.017 HRS.

                                           PRIM   PRIM    TOT    THRUST
             FUEL               PRES       TURB   ENG     FUEL     TO
TIME   RNG   USED    WEIGHT     ALT   TAS  TEMP   PEHF    FLOW   WEIGHT   FM   BHP    CT
(HRS) (NM)   (LB)     (LB)     (FT)  (KT)  (R)           (LB/HR)
1.785  198.0 2261.  20739.       0.    0.  2000.  1.000   1654.   1.232   .63 2795. .0053
1.802  198.0 2288.  20711.       0.    0.  2000.  1.000   1654.   1.232   .63 2790. .0053
```

```
TAXI   FOR   0.025   HRS.  AT GROUND IDLE ENGINE RATING

                                                  PRIM     PRIM      TOT    AUX     AUX     AUX
                FUEL               PRES                   TURB     ENG       FUEL   TURB    ENG     FUEL  TEMP
TIME     RNG    USED    WEIGHT     ALT      TAS   TEMP     PEHF      FLOW   TEMP    PEHF    FLOW   DEG
(HRS)   (NM)   (LB)     (LB)      (FT)     (KT)  (R)              (LB/HR) (R)            (LB/HR) (F)
1.802  198.0  2288.   20711.       0.       0.    950.   0.000     253.    ---     ---     ---    59.0
1.827  198.0  2295.   20705.       0.       0.    950.   0.000     253.    ---     ---     ---    59.0

                    MISSION FUEL REQUIRED =  2294.82
                    RESERVE FUEL REQUIRED =   255.00
                    TOTAL   FUEL REQUIRED =  2549.82
```

```
DATE 11/25/85   CH-46F   NASA AMES CALIBRATION                      PAGE  9
                                   H E S C O M P
                  HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

                               MISSION PERFORMANCE DATA
CHANGE PAYLOAD,  REMOVE    2200.  LB.

                FUEL           PRES
TIME    RANGE   USED   WEIGHT   ALT
(HRS)   (NM)    (LB)    (LB)   (FT)
0.000    0.0      0.   23000.    0.
0.033    0.0      0.   20800.    0.

TAXI  FOR  0.025  HRS. AT GROUND IDLE ENGINE RATING

                                          PRIM   PRIM    TOT    AUX   AUX    AUX
               FUEL          PRES         TURB   ENG     FUEL   TURB  ENG    FUEL  TEMP
TIME    RNG   USED  WEIGHT   ALT     TAS  TEMP   PEHF    FLOW   TEMP  PEHF   FLOW   DEG
(HRS)   (NM)  (LB)   (LB)    (FT)   (KT)  (R)          (LB/HR)  (R)        (LB/HR)  (F)
0.033    0.0    0.  20800.     0.     0.   950.  0.000   253.   ---   ---    ---   59.0
0.058    0.0    6.  20794.     0.     0.   950.  0.000   253.   ---   ---    ---   59.0

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 FOR  0.017 HRS.

                                          PRIM   PRIM    TOT    THRUST
               FUEL          PRES         TURB   ENG     FUEL     TO
TIME   RNG    USED  WEIGHT   ALT     TAS  TEMP   PEHF    FLOW   WEIGHT  FM   BHP    CT
(HRS)  (NM)   (LB)   (LB)    (FT)   (KT)  (R)          (LB/HR)
0.058    0.0    6.  20794.     0.     0.  2000.  1.000  1654.   1.229   .63 2794. .0053
0.075    0.0   34.  20766.     0.     0.  2000.  1.000  1654.   1.229   .63 2790. .0053

CLIMB  TO  5000.  FT. WITH  MAXIMUM R/C  AT MILITARY  ENGINE RATING
** TAS (AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

                                          PRIM PRM PRIM       CT'
               FUEL          PRES         TURB ENG ENG        OVER  ALFA
TIME   RNG    USED  WEIGHT   ALT     TAS  TEMP CDE PEHF   MU  SIGMA D/L     BHP    R/C
(HRS)  (NM)   (LB)   (LB)    (FT)   (KT)  (R)                       (DEG)         (FPM)
0.075    0.0   34.  20766.     0.    68.  2000. T   1.000 .17 0.057 -1.7    2821.  1524.
0.086    0.8   52.  20748.  1000.    69.  2000. T   1.000 .17 0.059 -1.7    2751.  1436.
0.098    1.6   71.  20729.  2000.    70.  2000. T   1.000 .17 0.061 -1.7    2682.  1348.
0.110    2.5   91.  20709.  3000.    71.  2000. T   1.000 .17 0.062 -1.6    2614.  1260.
0.123    3.4  111.  20689.  4000.    72.  2000. T   1.000 .18 0.064 -1.6    2546.  1171.
0.137    4.5  132.  20668.  5000.    73.  2000. T   1.000 .18 0.066 -1.6    2479.  1082.
```

```
        CRUISE AT   NORMAL   ENGINE RATING

                                             PRIM PRM PRIM        CT'
               FUEL               PRES            TURB ENG ENG         OVER  ALFA           SPEC
TIME   RNG     USED    WEIGHT     ALT      TAS   TEMP CDE PEHF    MU  SIGMA D/L    BHP     RNG
(HRS) (NM)     (LB)     (LB)      (FT)     (KT)  (R)                          (DEG)          (NMPP)
0.137    4.5   132.   20668.     5000.    116.  1856.  T   0.850 .28 0.066 -4.0 2139.  0.0913
0.352   29.5   406.   20394.     5000.    117.  1856.  T   0.850 .28 0.065 -4.1 2139.  0.0919
0.565   54.5   678.   20122.     5000.    118.  1856.  T   0.850 .28 0.064 -4.3 2139.  0.0925
0.777   79.5   948.   19852.     5000.    119.  1856.  T   0.850 .28 0.063 -4.4 2139.  0.0931
0.987  104.5  1217.   19583.     5000.    120.  1856.  T   0.850 .29 0.063 -4.5 2139.  0.0937
1.196  129.5  1484.   19316.     5000.    121.  1856.  T   0.850 .29 0.062 -4.7 2160.  0.0949
1.402  154.5  1747.   19053.     5000.    122.  1856.  T   0.850 .29 0.061 -4.8 2158.  0.0953
1.608  179.5  2010.   18790.     5000.    122.  1856.  T   0.850 .29 0.060 -4.9 2157.  0.0957
1.661  186.0  2078.   18722.     5000.    122.  1856.  T   0.850 .29 0.060 -4.9 2157.  0.0959

DESCEND TO H =      0.  FT.  ,R =   206.00 N.MI.  AT CONSTANT TAS

                                             PRIM PRM PRIM        CT '
               FUEL               PRES            TURB ENG ENG         OVER  ALFA
TIME   RNG     USED    WEIGHT     ALT      TAS   TEMP CDE PEHF    MU  SIGMA D/L    BHP      R/S
(HRS) (NM)     (LB)     (LB)      (FT)     (KT)  (R)                          (DEG)          (FPM)
1.661  186.0  2078.   18722.     5000.    120.  1734.  P   0.707 .29 0.060 -2.4  1778.     500.
1.695  190.0  2115.   18685.     4000.    120.  1734.  P   0.706 .29 0.060 -2.4  1776.     500.
1.728  194.0  2151.   18649.     3000.    120.  1733.  P   0.706 .29 0.060 -2.4  1775.     500.
1.761  198.0  2188.   18612.     2000.    120.  1733.  P   0.705 .29 0.059 -2.4  1773.     500.
1.795  202.0  2224.   18576.     1000.    120.  1732.  P   0.704 .29 0.059 -2.4  1771.     500.
1.828  206.0  2261.   18539.        0.    120.  1732.  P   0.704 .29 0.059 -2.4  1770.     500.

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 FOR  0.017 HRS.

                                             PRIM    PRIM     TOT    THRUST
               FUEL               PRES            TURB    ENG      FUEL     TO
TIME   RNG     USED    WEIGHT     ALT      TAS   TEMP    PEHF     FLOW   WEIGHT   FM   BHP     CT
(HRS) (NM)     (LB)     (LB)      (FT)     (KT)  (R)             (LB/HR)
1.828  206.0  2261.   18539.        0.      0.  2000.  1.000    1654.   1.380   .63 2799.  .0053
1.845  206.0  2288.   18512.        0.      0.  2000.  1.000    1654.   1.380   .63 2793.  .0053
```

```
TAXI  FOR  0.025  HRS. AT GROUND IDLE ENGINE RATING

                                     PRIM   PRIM   TOT   AUX   AUX   AUX
            FUEL          PRES       TURB   ENG    FUEL  TURB  ENG   FUEL TEMP
TIME   RNG  USED  WEIGHT  ALT   TAS  TEMP   PEHF   FLOW  TEMP  PEHF  FLOW  DEG
(HRS)  (NM) (LB)   (LB)   (FT)  (KT) (R)         (LB/HR) (R)       (LB/HR) (F)
1.845 206.0 2288. 18512.     0.    0.  950. 0.000  253.  ---   ---   ---   59.0
1.870 206.0 2295. 18505.     0.    0.  950. 0.000  253.  ---   ---   ---   59.0

              MISSION FUEL REQUIRED =  2294.53
              RESERVE FUEL REQUIRED =   255.00
              TOTAL   FUEL REQUIRED =  2549.53

********************************************************************************

                        END  OF  SUCCESSFUL  CASE

********************************************************************************
```

```
DATE 11/25/85  CH-46F   NASA AMES CALIBRATION
                                             HESCOMP SUMMARY

                                     NUMBER OF ITERATION(S)   1

ROTORS                               MAIN ROTOR      TAIL ROTOR      AUX. PROPELLER
    DIAMETER                           50.966           0.000              0.000
    NO. OF BLADES                       3.000           0.000              0.000
    SOLIDITY                            0.075           0.000              0.000
    CT/SIGMA                            0.095           0.000
    DISK LOADING                        5.637           0.000
    TIP SPEED                         707.017           0.000              0.000
    DRIVE SYS. RATING                2800.000           0.000              0.000
    WEIGHT                           2637.505           0.000              0.000
    ROTOR CYCLE NO.                     2.000

PROPULSION                            PRIMARY          AUXILARY
    NUMBER OF ENGINES                      2.            NONE
    ENGINE CYCLE                        1.761            NONE
    POWER PER ENGINE                 1400.000            NONE
    WEIGHT PER ENGINE                 382.200            NONE

DIMENSIONS                      VERTICAL TAIL        HORIZONTAL TAIL        WING
    AREA                             0.0                  0.0               0.0
    ASPECT RATIO                     1.000                0.000             1.00
    TAPER RATIO                      0.000                0.000             0.000
    SPAN                             0.0                  0.0               1.0

    FUSELAGE LENGTH                  43.7          FUSELAGE WIDTH           7.3
    OVERALL LENGTH                   83.9

WEIGHTS          (LBS)          %                    (LBS)          %
PROPULSION     6261.2        27.2    STRUCTURE      3294.7        14.3
   EMPTY         13341.8        58.0     OPERATING      13975.2       60.8
   FUEL           2549.8        11.1     GROSS          23000.0      100.0
   PAYLOAD        6475.0        28.2     WING LOADING       0.0

AERODYNAMICS
   FLAT PLATE AREA                      36.800      WETTED AREA              1242.
   GROSS WEIGHT/FLATPLATE AREA         625.000      MEAN SKIN FRICTION   0.029626
```

```
                M I S S I O N   D A T A
             SEG.       SEG.     SEG.              SEG.
             WEIGHT     TIME     FUEL      ALT.    DIST
             START      (MIN)    (LBS)     (FT)    (NMI)
             (LBS)

TAXI        23000.0       1.5       6.3       0.0
TOFF/LND    22993.7       1.0      27.6       0.0           FIG MERIT =0.626
CLIMB       22966.1       5.0     131.4                6.2
CRUISE      22834.7      89.6    1904.9    5000.0    171.8   EAS SPEED =109.9
DESCENT     20929.8      10.0     190.7               20.0
TOFF/LND    20739.1       1.0      27.6       0.0           FIG MERIT =0.626
TAXI        20711.5       1.5       6.3       0.0
RNG= 198.NM  MSN FUEL=   2295.   RSRV FUEL=   255.   TOT FUEL=   2550.   TIME= 110.

CHG PYLD    -2200.0(LBS)
TAXI        20800.0       1.5       6.3       0.0
TOFF/LND    20793.7       1.0      27.6       0.0           FIG MERIT =0.626
CLIMB       20766.1       3.7      98.5                4.5
CRUISE      20667.6      91.4    1945.7    5000.0    181.6   EAS SPEED =113.7
DESCENT     18721.9      10.0     182.5               20.0
TOFF/LND    18539.3       1.0      27.6       0.0           FIG MERIT =0.626
TAXI        18511.8       1.5       6.3       0.0
RNG= 206.NM  MSN FUEL=   2295.   RSRV FUEL=   255.   TOT FUEL=   2550.   TIME= 112.
```

C. 44-PASSENGER TILT ROTOR

1. Description

The first of the two tilt rotor designs used in this study is a civilian derivative of the V-22 OSPREY. This aircraft design was the subject of a study [Ref. 7] conducted by Bell Helicopter TEXTRON (BHT) wherein the 44-passenger tilt rotor was shown to be substantially more cost-effective (despite a higher acquisition cost) than the 44-passenger Boeing VERTOL 234LR. This tilt rotor design features two General Electric T64-717 engines that each produce 4855 shp. Reference 7 was used to compile the information in Table 3.

TABLE 3

BELL HELICOPTER TEXTRON 44-PASSENGER TILT ROTOR

Type:	Twin-engined, commercial transport aircraft
Engines:	Two 4855 shp General Electric T64 shaft-turbines
Rotors:	Two three-bladed rotors on wingtip nacelles
Dimensions:	
Diameter of main rotors:	38 ft 0 in
Length overall:	60 ft 11 in
Length of fuselage:	60 ft 11 in
Wing span:	47 ft 10 in
Main rotor disc area:	2,268 sq ft
Weights and Loadings:	
Weight empty, equipped:	26,676 lb
Max takeoff and landing weight:	44,000 lb
Max disc loading:	19.4 psf
Performance	
Max permissable speed:	360 knots
Max cruising speed:	300 knots
Service ceiling:	34,000 ft
Ranges (with reserve fuel)	
At 44,000 lb (9124 lb payload):	725 naut mi
Fuel Capacity:	
Standard configuration:	1043 US gal
Accommodation:	
Crew:	4
Passengers:	44

2. Aircraft Calibration Using VASCOMP II

Basic data for the 44-passenger tilt rotor was also obtained from NASA Ames Research Center. The similarity between VASCOMP II and HESCOMP permitted using an identical calibration technique as that described in paragraph IV B 2 above. Table 4 shows the comparisons between the aircraft as described in Ref. 7 and as portrayed through the VASCOMP II output results.

TABLE 4

COMPARISON OF BHT AND VASCOMP II 44-PAX TILT ROTOR

	BHT	VASCOMP	% DIFFERENCE
Dimensions:			
Main rotor diameter:	38.000 ft	38.000 ft	0.000
Length overall:	60.917 ft	60.900 ft	0.028
Weights and Loading:			
Weight empty:	26,676 lb	26,676 lb	0.000
Operating weight:	27,876 lb	27,876 lb	0.000
Payload:	9,124 lb	9,124 lb	0.000
Fuel:	7,000 lb	7,000 lb	0.000
Gross weight	44,000 lb	44,000 lb	0.000
Ranges (normal power):			
At 43,676 lb:	725 nm	725 nm	0.000

3. Program Data

VASCOMP II output from the calibration run is shown on pages 44 - 60. It should be noted that the output closely parallels the format and sequence of output generated using HESCOMP. Due to the limited information available, only one mission was programmed. A maximum takeoff gross weight of 44,000 pounds was used for the mission to calibrate the aircraft′s maximum range.

```
 DATE 11/25/85   44 PASSENGER TILT ROTOR                                      PAGE  1

                                    V A S C O M P   I I

                 V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

"LOC." = LOCATION NUMBER GIVEN ON INPUT SHEET
"NUM " = NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX OF 5)
"VAL " = VALUE FOR VARIABLE CORRESPONDING TO LOC.
"VAL1" = VALUE FOR VARIABLE CORRESPONDING TO LOC.+0001
"VAL2" = VALUE FOR VARIABLE CORRESPONDING TO LOC.+0002
"VAL3" = VALUE FOR VARIABLE CORRESPONDING TO LOC.+0003
      ETC.

LOC. NUM       VAL          VAL1          VAL2          VAL3          VAL4

   1   5      1.000      0.0000E+00    0.0000E+00     1.000         4.000
   6   5      2.000       2.000         1.000         1.000        0.0000E+00
  11   3    0.0000E+00   0.0000E+00    0.0000E+00
  14   5    0.4400E+05   0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00
  19   5      1.000       0.6000        300.0         300.0         3.000
  25   2    0.0000E+00    1.115
  96   2      5.000       30.00
 103   5      3.000       0.2230        0.2230        100.0        -6.500
 108   5      1.000       4.000         1.000         37.40         0.1500
 113   1      1.200
 114   3      0.6000      50.25        0.8000E-01
 117   3      11.40      0.0000E+00     1.000
 122   1      60.92
 126   1    0.0000E+00
 129   3      1.500       34.00         0.1000
 132   1      0.1230
 133   4      0.7000      50.50        0.0000E+00     1.000
 151   3    0.0000E+00   0.0000E+00    0.0000E+00
 159   5    0.0000E+00   0.0000E+00     44.00         4.000         1.000
 164   3      20.00       32.02         17.00
 201   2      1.650       9710.
 204   1      2.000
 206   3      0.9700     0.0000E+00     1.080
 210   1      1.105
 213   5      2.000      0.2000E+05     280.0        0.0000E+00     1.098
 223   2      2.000       775.0
 225   2      19.40       38.00
 200  1     2.000
 227  4    0.1300       67.00        3.000       0.2500
 234  1    0.7500
 305  1    0.1500E-01
 307  1     10.50
 312  1     1.000
 330  5    0.2000E+07    6.280       -1.000       0.3000       0.3500
 308  1     2.000
 317  2    0.0000E+00    4.000
 335  2    0.0000E+00   0.0000E+00
 400  4    0.2668E+05   6895.        1200.        9124.
 480  3     1.000       338.0        9.885
 167  2     3.000       1.000
 483  3    0.1255       2.668        458.0
 487  1     25.50
 488  2     1.730       624.9
 490  2    0.4000E-03   17.00
 493  3     1.500       1.500        40.00
 496  3     1.000       1.000        1.000
 499  1    0.2219E-01
 404  5     19.50       0.9540E-02   0.0000E+00   0.0000E+00   0.9000E-02
 409  1    0.4341
 420  1     121.8
 422  5    0.4300E-01   0.8000       1.000       0.6000       236.3
 427  3    0.1700       0.3200       0.3400
 434  2    0.4440       0.4000
 450  1     5.000
 453  2     333.0       0.2705E-01
 456  3    0.1500       15.77        1.000
 394  1     4.000
 396  4     61.00       0.1200       44.00        2.200
 457  1    -1.000
 464  1     1.106
 142  1    0.2500
 257  3    0.0000E+00    1.000       30.00
 260  2     1.000       500.0
 263  1    0.5000E-01
  94  1     1.000
  98  1     2.000
 123  2     1.250        2.500
 139  3    0.7580E-01   0.0000E+00   0.2330
 313  1     1.000

         ECONOMICS INPUT
  99  1    0.0000E+00
1675  5     3.620        1.100       0.0000E+00    350.0       0.0000E+00
1680  4    0.0000E+00   0.0000E+00   0.0000E+00   0.5600E+05
1684  5    0.1492        3.000       0.1500E-01    15.00        5000.
```

```
1680  5     5000.          1.000          0.0000E+00     12.00          0.1500
1694  2     2800.          10.00

          G.E.  T64 ENGINE DATA
 139  3     0.5000E-01     0.0000E+00     0.2600
1201  5      1.000          1.000         0.0000E+00     2.000          0.0000E+00
1220  2      1.005          1.060
1223  1     0.9170
1301  5      1.650         0.0000E+00     698.0          0.0000E+00     1200.
1306  5      1270.          1745.         1820.          1850.          7.000
1311  5      1200.          1400.         1600.          1800.          1900.
1316  2      2000.          2200.
1319  1      5.000
1320  5     0.0000E+00     0.2000         0.4000         0.6000         0.8000
1326  5     0.8000E-01     0.7500E-01     0.6600E-01     0.5000E-01     0.1500E-01
1332  5     0.3390         0.3340         0.3300         0.3200         0.2910
1338  5     0.6120         0.6230         0.6330         0.6350         0.6300
1344  5     0.9260         0.9520         0.9800          1.000          1.016
1350  5      1.082          1.118          1.153          1.188          1.215
1356  5      1.245          1.288          1.330          1.375          1.415
1362  5      1.570          1.625          1.680          1.740          1.805
1374  1      7.000
1375  5      1200.          1400.          1600.          1800.          1900.
1380  2      2000.          2200.
1383  1      5.000
1384  5     0.0000E+00     0.2000         0.4000         0.6000         0.8000
1390  5     0.9700E-01     0.1000         0.1050         0.1100         0.1200
1396  5     0.2000         0.2030         0.2080         0.2160         0.2260
1402  5     0.3050         0.3110         0.3200         0.3310         0.3450
1408  5     0.4230         0.4330         0.4470         0.4600         0.4800
1414  5     0.4850         0.4980         0.5140         0.5320         0.5530
1420  5     0.5470         0.5670         0.5840         0.6030         0.6280
1426  5     0.6780         0.7030         0.7240         0.7490         0.7770
1438  5      7.000          1200.          1400.          1600.          1800.
1443  3      1900.          2000.          2200.
1447  1      5.000
1448  5     0.0000E+00     0.2000         0.4000         0.6000         0.8000
1454  5     0.6440         0.6510         0.6580         0.6650         0.6750
1460  5     0.8800         0.8830         0.8890         0.8980         0.9100
1466  5     0.9380         0.9390         0.9420         0.9480         0.9570
1472  5     0.9880         0.9910         0.9920         0.9960          1.002
1478  5      1.008          1.010          1.014          1.020          1.025
1484  5      1.025          1.027          1.032          1.039          1.046
1490  5      1.059          1.062          1.066          1.073          1.083
1502  5      7.000          1200.          1400.          1600.          1800.
1507  3      1900.          2000.          2200.
1511  5      5.000         0.0000E+00     0.2000         0.4000         0.6000
1516  1     0.8000
```

```
1518  5      0.5060         0.5060         0.5060         0.5060         0.5060
1524  5      0.6860         0.6860         0.6860         0.6860         0.6860
1530  5      0.8500         0.8500         0.8500         0.8500         0.8500
1536  5      0.9740         0.9740         0.9740         0.9740         0.9740
1542  5       1.023          1.023          1.023          1.023          1.023
1548  5       1.068          1.068          1.068          1.068          1.068
1554  5       1.151          1.151          1.151          1.151          1.151

         FLIGHT MISSION PROFILE
  27  5       1.000          2.000          3.000          4.000          5.000
  32  5       2.000          1.000          9.000          6.000          100.0
 501  2      0.0000E+00     0.0000E+00
 511  2      0.2500E-01     0.2500E-01
 541  2      0.7850         0.7850
 601  2       3.000          3.000
 611  2      0.0000E+00     0.0000E+00
 621  2       1.000          1.000
 661  2      0.1667E-01     0.1667E-01
 671  2       1.105          1.105
 681  2      0.1667E-01     0.1667E-01
 691  1       1.000
 711  1      0.0000E+00
 721  1       5000.
 741  1      0.2000E+05
 751  1       1.000
 761  1       20.00
 771  1      0.7850
 801  1       1.000
 821  1      0.0000E+00
 831  1       100.0
 851  1       725.0
 861  1       2.000
 881  1      0.7850
 901  1       1.000
 921  1      0.0000E+00
 931  1      -20.00
 951  1       5000.
 961  1       725.0
 971  1      0.0000E+00
 981  1      0.7850
1001  1       2.000
1011  1      0.1110
1021  1      0.0000E+00
1031  1      0.3330
1061  1      0.7850
1111  1       5000.
 139  3      0.7580E-01     0.0000E+00     0.2500
 100  1       1.000
```

```
DATE 11/25/85  44 PASSENGER TILT ROTOR                                  PAGE  2

                              V A S C O M P  II

     V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
     FIXED EQUIP GROUP                     FIXED USEFUL LOAD
 WAPU              338.00          WCREW ( 3. )          510.00
 WINSTR            263.13          WSTU  ( 1. )          130.00
 WHYD              303.42          WCBAG                  98.00
 WELEC             436.47          WUF                   155.32
 WAV               458.00          WOIL                   65.83
 WFUR             3157.64          WSRV                   82.00
 WAC               480.79          WH2O                   72.00
 WAI               624.90          WEMER                  40.00
 WAUXG              17.60          WCATER                 47.00

 WFE              6079.95          WFUL                 1200.15
```

```
DATE 11/25/85  44 PASSENGER TILT ROTOR                                  PAGE  3
                                   V A S C O M P  II
               V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
S I Z E  D A T A  THIS RUN CONVERGED IN  1 ITERATION(S)
                              GROSS WEIGHT =  44000.  LB

     FUSELAGE
         LF             LENGTH                               60.9      FT
         WF             WIDTH                                 9.2      FT
         SF             WETTED AREA                         1467.      SQFT
     WING
         AR             ASPECT RATIO                          5.55
         SW             AREA                                440.0      SQFT
         B              SPAN                                 49.4      FT
         CBARW          GEOM. MEAN CHORD                      8.9      FT
         LAMBDA C       QUARTER CHORD SWEEP                  -6.5      DEG
         LAMBDA         TAPER RATIO                          1.000
         (T/C)R         ROOT THICKNESS                       0.223
         (T/C)T         TIP  THICKNESS                       0.223
         WG/SW          WING LOADING                         100.0     LB/SQFT
         C BAR / D      MEAN CHORD / PROP. DIA.              0.234
     HOR. TAIL
         ARHT           ASPECT RATIO                          4.00
         SHT            AREA                                125.7      SQFT
         BHT            SPAN                                 22.4      FT
         CBARHT         MEAN CHORD                            5.7      FT
         (T/C)HT        THICKNESS / CHORD                    0.150
         ELTH           MOMENT ARM                           37.4      FT
         VBARH          VOLUME COEF.                         1.200
     VERT. TAIL
         ARVT           ASPECT RATIO                          1.50
         SVT            AREA                                 78.6      SQFT
         BVT            SPAN                                 10.9      FT
         CBARVT         MEAN CHORD                            7.3      FT
         (T/C)VT        THICKNESS / CHORD                    0.100
         ELTV           MOMENT ARM                           34.0      FT
         VBARV          VOLUME COEF.                         0.123
     PRIMARY ENG. NACELLE
         LN             LENGTH                               17.4      FT
         DBARN          MEAN DIAMETER                         5.3      FT
         SN             WETTED AREA                         578.1      SQFT
     LIFT ENG. NACELLE
                        NO LIFT PROPULSION SELECTED
```

```
PROPELLER
    D              DIAMETER                              38.0     FT
    SIGMA R/P      SOLIDITY                             0.110
    WG/A           DISC LOADING                          19.4     LB/SQFT
    CT/SIGMA       THRUST COEFF. / SOLIDITY             0.130
    NR             NO. OF PROPELLERS                    2.000
    NO. BLADES     NO. OF BLADES/PROP                   3.000
    SR             BLADE CUTOUT / RADIUS RATIO          0.080
    VT             TIPSPEED                             775.0     FT/SEC
```

```
DATE 11/25/85  44 PASSENGER TILT ROTOR                                   PAGE  4

                              V A S C O M P  II

           V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
P A S S E N G E R  S I Z I N G  D A T A

                         TOURIST               FIRST CLASS
                         -------               -----------
           NO. OF PASS.       44.                   0.
           NO. ABREAST         4.                   0.
           NO.OF AISLES        1.                   0.
           UNIT SEAT WIDTH    20.  IN.              0.  IN.
           SEAT PITCH         32.  IN.              0.  IN.
           AISLE WIDTH        17.  IN.              0.  IN.

           NUMBER OF LAVATORIES        1.00
           GALLEY AREA                11.9 SQ. FT.
           CLOSET AREA                 3.1 SQ. FT.
           CABIN DIAMETER            103.3 IN.      *** TOURIST CLASS CRITICAL
           BODY DIAMETER             109.9 IN.      *** TOURIST CLASS CRITICAL

           NOSE SECTION LENGTH        11.4 FT.
           TAIL SECTION LENGTH        22.9 FT.
           CONST. DIA. LENGTH         26.6 FT.

             TOTAL FUSELAGE LENGTH        60.9 FT.
```

```
DATE 11/25/85   44 PASSENGER TILT ROTOR                                   PAGE  5
                                   V A S C O M P  II
                  V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
W E I G H T S   D A T A    IN LBS
                  EMLF           MANEUVER LOAD FACTOR                        3.000
                  GLF            GUST LOAD     FACTOR                        2.263
                  ULF            ULTIMATE LOAD FACTOR                        4.500

              STRUCTURES GROUP
                  K8  WW         WING                                        2376.
                  K9  WHT        HOR. TAIL                                    163.
                  K10 WVT        VERT. TAIL                                   163.
                  K11 WB         FUSELAGE                                    4223.
                  K12 WLG        LANDING GEAR                                1892.
                  K13 WLES       LIFT ENGINE SECTION                            0.
                  K14 WPES       PRIMARY ENGINE SECTION                       475.
                  SPACE5(2)      PRIMARY ENGINE ACOUSTIC TREAT.                 0.
                  DELTA WST      STRUCTURE WEIGHT INCREMENT                     0.
                  WST            TOTAL STRUCTURE WEIGHT                      9292.
              PROPULSION GROUP
                  K2  WR/P       ROTOR SYSTEM                                3478.
                      WPRB           (WT. OF BLADES =       0. )
                      WPH            (WT. OF HUB    =       0. )
                      WBF            (WT. OF FOLD   =       0. )
                  K3  WDS        DRIVE SYSTEM                                3591.
                      WPDS           (WT. OF MAIN DRIVE =       0. )
                      WTRDS          (WT. OF TAIL DRIVE =       0. )
                  K4  WEL        LIFT ENGINES                                   0.
                  K5  WEP        PRIMARY ENGINES                             1396.
                  K6  WLEI       LIFT ENGINE INSTALLATION                       0.
                  K7  WPEI       PRIMARY ENGINE INSTALLATION                  232.
                  K21 WFS        FUEL SYSTEM                                  189.
                  DELTA WP       PROPULSION GROUP WEIGHT INCREMENT              0.
                  WP             TOTAL PROPULSION GROUP WEIGHT               8886.
              FLIGHT CONTROLS GROUP
                  K15 WCC        COCKPIT CONTROLS                              92.
                  K16 WUC        UPPER   CONTROLS                            1510.
                  K17 WH         HYDRAULICS                                     0.
                  K18 WFW        FIXED WING CONTROLS                          420.
                  K19 WSAS       SAS                                            0.
                  K20 WTM        TILT MECHANISM                               396.
                  DELTA WFC      CONTROL WEIGHT INCREMENT                       0.
                  WFC            TOTAL CONTROL WEIGHT                        2418.
```

WFE	WEIGHT OF FIXED EQUIPMENT	6080.
WE	WEIGHT EMPTY	26676.
WFUL	FIXED USEFUL LOAD	1200.
OWE	OPERATING WEIGHT EMPTY	27876.
WPL	PAYLOAD	9124.
(WF)A (WF)W	FUEL	7000. 7000.
WG	GROSS WEIGHT	44000.

```
DATE 11/25/85  44 PASSENGER TILT ROTOR                                PAGE  6

                                   V A S C O M P   II
         V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
P R O P U L S I O N   D A T A

    PRIMARY PROPULSION CYCLE NO.     1.650

         TURBOSHAFT ENGINE

          2.   ENGINES

         BHP*P  MAX. STANDARD S.L. STATIC H.P.      9710.   H.P.
         POWER LOADING = 0.2207

         ENGINE SIZE WAS FIXED BY INPUT

    ACCESSORY HORSEPOWER EXTRACTED =   30.00  H.P.

    NO LIFT ENGINE CYCLE SELECTED

    XMSN SIZED AT 100.  PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
    (MAX.STANDARD S.L.  STATIC H.P.),100.0 PERCENT HOVER RPM

    TRANSMISSION EFFICIENCY = 0.9700
```

```
DATE 11/25/85  44 PASSENGER TILT ROTOR                                      PAGE  7

                                        V A S C O M P  II

                V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

A E R O D Y N A M I C S  D A T A
         FE              TOTAL EFFECTIVE FLATPLATE AREA       13.817  SQFT
         SWET            TOTAL WETTED AREA                     3252.  SQFT
         CBARF           MEAN SKIN FRICTION COEFF.          0.004249

D R A G  B R E A K D O W N          IN  SQFT
         FEW             WING FE                               0.000
         FEF             FUSELAGE FE                           7.217
         FEVT            VERT.  TAIL FE                        0.000
         FEHT            HOR.   TAIL FE                        0.000
         FEN             PRIMARY ENG. NACELLE FE               0.000
         FELN            LIFT ENG. NACELLE FE                  0.000
         DELTA FE        INCREMENTAL FE                        6.600

A E R O D Y N A M I C  C O E F F .
         A1                                                  0.59515
         A2                                                 -0.11302
         A3                                                  0.12091
         A4                                                  0.16725
         A5                                                  0.03140
         A6                                                  0.91255
         A7                                                  0.07419
         CL ALPHA        3-D LIFT SLOPE                      4.85042 PER RADIAN
         E               OSWALD   FACTOR                       0.77362
```

```
DATE 11/25/85  44 PASSENGER TILT ROTOR                                  PAGE  8

                              V A S C O M P  II
              V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
                   M I S S I O N   P E R F O R M A N C E   D A T A


TAXI FOR 0.025 HRS AT GROUND IDLE ENGINE RATING; TEMPERATURE =  59.0 DEG.F

              FUEL             PRES         TURB ENG  PETF
TIME    RNG   USED   WEIGHT    ALT    TAS   TEMP CODE  OR    LETF
(HRS)   (NM)  (LB)    (LB)     (FT)   (KT)  (R)        PEHE
0.000    0.0     0.  44000.      0.     0.  1200.  T   0.071 0.000
0.025    0.0    26.  43974.      0.     0.  1200.  T   0.071 0.000

TAKEOFF, HOVER, OR LAND AT PETF = 1.000  LETF = 0.000 FOR  0.017 HRS.
VERTICAL RATE OF CLIMB =    0.0 FT/MIN                 TEMPERATURE =  59.0 DEG.F

              FUEL             PRES         TURB ENG  PETF        THRUST
TIME    RNG   USED   WEIGHT    ALT    TAS   TEMP CODE  OR    LETF   TO      FM     CT
(HRS)   (NM)  (LB)    (LB)     (FT)   (KT)  (R)        PEHE       WEIGHT
0.025    0.0    26.  43974.      0.     0.  1850.  T   1.000 0.000 1.139 0.709 0.1167
0.042    0.0   108.  43892.      0.     0.  1850.  T   1.000 0.000 1.141 0.709 0.1167

CLIMB   TO 20000.   FT. WITH   MAXIMUM R/C  AT MILITARY  ENGINE RATING

              FUEL             PRES         TURB ENG  PETF               MACH        THETA
TIME    RNG   USED   WEIGHT    ALT    TAS   TEMP CODE  OR    EAS   MACH DIV    R/C     F
(HRS)  (NM)   (LB)    (LB)     (FT)   (KT)  (R)        PEHE                   (FPM)(DEG)
0.042    0.0  108.  43892.      0.  176.  1820.  T   0.988 176.3 .266 .491 4052.  20.0
0.062    3.5  208.  43792.   5000.  183.  1820.  T   0.960 169.9 .281 .482 3252.  17.9
0.088    8.2  321.  43679.  10000.  195.  1820.  T   0.963 167.3 .305 .478 2538.  15.6
0.121   14.5  449.  43551.  15000.  211.  1820.  T   0.965 167.0 .336 .477 1950.  13.6
0.163   23.5  597.  43403.  20000.  227.  1820.  T   0.967 165.8 .370 .476 1176.  11.4

CRUISE AT   NORMAL   ENGINE RATING          TEMPERATURE = -12.3 DEG.F

              FUEL             PRES         TURB ENG PETF               MACH SPEC    ETAP
TIME   RNG    USED   WEIGHT    ALT    TAS   TEMP CDE  OR    EAS   MACH DIV  RANGE   PROP
(HRS)  (NM)   (LB)    (LB)     (FT)   (KT)  (R)       PEHE                  (NMPP)
0.163   23.5   597.  43403.  20000.  331.  1745.  T  0.883 241.7 .539 .539 .11690 .855
0.395  100.0  1252.  42748.  20000.  333.  1745.  T  0.883 243.2 .542 .540 .11758 .853
0.695  200.0  2102.  41898.  20000.  336.  1745.  T  0.883 245.1 .546 .542 .11842 .851
0.992  300.0  2947.  41053.  20000.  338.  1745.  T  0.883 246.9 .550 .544 .11920 .850
```

```
1.288 400.0 3785.  40215.  20000.  341.  1745.  T   0.883 248.6 .554 .546 .11993 .848
1.582 500.0 4619.  39381.  20000.  343.  1745.  T   0.883 250.4 .558 .548 .12072 .847
1.873 600.0 5448.  38552.  20000.  345.  1745.  T   0.883 251.8 .561 .549 .12133 .845
2.099 677.8 6089.  37911.  20000.  346.  1745.  T   0.883 252.9 .564 .550 .12179 .844

DESCEND TO H =      0. FT.  ,R =   725.00 N.MI. AT MAX. SPEED

            FUEL              PRES         TURB ENG  PETF                MACH         THETA
TIME  RNG   USED    WEIGHT    ALT    TAS   TEMP CODE  OR    EAS    MACH  DIV   R/S      F
(HRS) (NM)  (LB)     (LB)     (FT)   (KT)  (R)       PEHF                      (FPM) (DEG)
2.099 677.8 6089.  37911.  20000.  369.  1270.  T    0.289 269.1 .600 .556 3265.  -4.9
2.124 687.2 6119.  37881.  15000.  376.  1270.  T    0.252 298.3 .600 .563 4120.  -6.9
2.145 694.8 6146.  37854.  10000.  291.  1270.  T    0.227 250.0 .456 .549 1416.  -2.0
2.204 711.9 6226.  37774.   5000.  269.  1270.  T    0.189 250.0 .414 .549 1711.  -2.8
2.252 725.0 6297.  37703.      0.  250.  1270.  T    0.155 250.0 .378 .550 1678.  -3.0

TAKEOFF, HOVER, OR LAND AT PETF = 1.000  LETF = 0.000 FOR  0.017 HRS.
VERTICAL RATE OF CLIMB =     0.0 FT/MIN            TEMPERATURE =  59.0 DEG.F

            FUEL              PRES         TURB ENG  PETF        THRUST
TIME   RNG  USED    WEIGHT    ALT    TAS   TEMP CODE  OR   LETF    TO     FM      CT
(HRS)  (NM) (LB)     (LB)     (FT)   (KT)  (R)       PEHF        WEIGHT
2.252 725.0 6297.  37703.      0.     0.  1850.  T   1.000 0.000 1.328 0.709 0.1167
2.269 725.0 6379.  37621.      0.     0.  1850.  T   1.000 0.000 1.331 0.709 0.1167

TAXI FOR 0.025 HRS AT GROUND IDLE ENGINE RATING; TEMPERATURE =  59.0 DEG.F

            FUEL              PRES         TURB ENG  PETF
TIME   RNG  USED    WEIGHT    ALT    TAS   TEMP CODE  OR   LETF
(HRS)  (NM) (LB)     (LB)     (FT)   (KT)  (R)       PEHF
2.269 725.0 6379.  37621.      0.     0.  1200.  T   0.071 0.000
2.294 725.0 6405.  37595.      0.     0.  1200.  T   0.071 0.000

      TRANSFER ALTITUDE TO    5000.  FT.

                                 FUEL                   PRES.
       TIME      RANGE           USED       WEIGHT      ALT.
       (HRS)     (N.M.)          (LBS)      (LBS.)      (FT)
       2.294      725.00         6404.9      37595.         0.
       2.294      725.00         6404.9      37595.      5000.
```

```
LOITER FOR  0.333 HRS.  FOR RESERVE FUEL     TEMPERATURE=   41.2 DEG.F

            FUEL          PRES       TURB ENG PETF             MACH  FUEL  ETAP
TIME  RNG   USED  WEIGHT  ALT   TAS  TEMP CDE  OR   EAS  MACH  DIV  RATE  PROP
(HRS) (NM)  (LB)   (LB)   (FT)   (KT) (R)      PEHF                 (LB-HR)
2.294 725.0 6405. 37595.  5000. 152. 1350. P  0.313 141.2 .234 .452  1794. .831
2.405 725.0 6604. 37396.  5000. 164. 1349. P  0.310 152.3 .252 .473  1789. .824
2.516 725.0 6803. 37197.  5000. 162. 1347. P  0.308 150.4 .249 .471  1779. .824
2.627 725.0 7000. 37000.  5000. 160. 1345. P  0.305 148.6 .246 .468  1769. .824
2.627 725.0 7000. 37000.  5000. 160. 1345. P  0.305 148.6 .246 .468  1769. .824

              MISSION FUEL REQUIRED =  6404.87
              RESERVE FUEL REQUIRED =   595.12
              TOTAL   FUEL REQUIRED =  7000.00

********************************************************************************


                         END   OF   SUCCESSFUL   CASE


********************************************************************************
```

```
DATE 11/25/85   44 PASSENGER TILT ROTOR                                        PAGE  1

                                   V A S C O M P  II

               V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
                                    S U M M A R Y

                                              ITERATION NO.   =   1

GROSS WEIGHT         =    44000.               WING AREA            =    440.00
NO.PRIMARY ENGINES   =        2.               WING LOADING         =    100.00
PRIMARY THR.OR.PWR   =     9710.               SPAN                 =     49.40
PRIM. T/W OR BHP/W   =    0.2207               ASPECT RATIO         =      5.55
1ST CLASS PASS.      =        0.               1/4 CHORD SWEEP      =     -6.50
TOURIST PASS.        =       44.               TAPER RATIO          =    1.0000
FUSELAGE LENGTH      =     60.92               FUSELAGE WIDTH       =      9.16
HORIZ. TAIL AREA     =      126.               VERT. TAIL AREA      =       79.
EMPTY WEIGHT         =    26676.               OPER.WEIGHT EMPTY    =    27876.
PAYLOAD WEIGHT       =     9124.               WEIGHT OF FUEL       =     7000.
TOTAL WETTED AREA    =     3252.               EFF.FLAT PL. AREA    =    13.817
MEAN S.F. COEFF.     =   0.00425               NO.OF LIFT ENGINES   =        0.
LIFT ENG. THRUST     =        0.               LIFT THRUST/GRS WT   =    0.0000
```

```
                      M I S S I O N   D A T A

                   SEG.      SEG.              SEG.
                   TIME      FUEL     ALT.     DIST
                  (MIN)     (LBS)     (FT)    (NMI)

        TAXI        1.5      26.2      0.0
        TOFF/LND    1.0      81.9      0.0
        CLIMB       7.3     488.7              23.5
        CRUISE    116.1    5492.3  20000.0    654.4     MACH NO.  =0.564
        DESCENT     9.2     207.6              47.2
        TOFF/LND    1.0      81.9      0.0
        TAXI        1.5      26.2      0.0

RNG= 725.NM MSN.FUEL= 6405.  RSRV.FUEL=  595.  TOT.FUEL= 7000.  BLOCK TIME= 138.
```

D. 25-PASSENGER TILT ROTOR

1. Description

This tilt rotor design is, in actuality, the V-22 OSPREY that was discussed in Chapter II - BACKGROUND. It is described in reference 6 and reference 7. Both references were used to obtain the specifications listed in Table 5.

TABLE 5

BELL/BOEING VERTOL 25-PASSENGER TILT ROTOR

Type:	Twin-engined, military transport aircraft
Engines:	Two 4855 shp General Electric T64 shaft-turbines
Rotors:	Two three-bladed rotors on wingtip nacelles
Dimensions:	
Diameter of main rotors:	38 ft 0 in
Length overall:	56 ft 10 in
Length of fuselage:	56 ft 10 in
Wing span:	46 ft 6 in
Main rotor disc area:	2,268 sq ft
Weights and Loadings:	
Weight empty, equipped:	26,858 lb
Max takeoff and landing weight:	43,800 lb
Max disc loading:	19.300 psf
Performance:	
Max permissable speed:	360 knots
Max cruising speed:	300 knots
Service ceiling:	34,000 ft
Ranges (with reserve fuel):	
At 43,800 lb (10,000 lb payload):	400 naut mi
At 35,400 lb (1,600 lb payload):	920 naut mi
Fuel Capacity:	
Standard configuration:	1043 US gal
Accommodation:	
Crew:	4
Passengers:	25

2. Aircraft Calibration Using VASCOMP II

Basic data for general dimensions, aerodynamics, and engine performance is identical to that used for the 44-passenger tilt rotor aircraft. Table 6 shows the values for aircraft specifications as obtained from references 6 and 7 and as obtained using VASCOMP II.

TABLE 6

COMPARISON OF BELL/BOEING AND VASCOMP 25-PAX TILT ROTOR

	BELL/BOEING	VASCOMP	% DIFFERENCE
Dimensions:			
Main rotor diameter:	38.000 ft	38.000 ft	0.000
Length overall:	56.833 ft	56.600 ft	0.410
Weights and Loading:			
Weight empty:	26,858 lb	26,858 lb	0.000
Operating weight:	NOT SHOWN	29,268 lb	
Payload:	10,000 lb	10,000 lb	0.000
Fuel:	7,000 lb	7,000 lb	0.000
Gross weight:	43,800 lb	43,800 lb	0.000
Ranges (normal power):			
At 43,800 lb:	400 nm	400+ nm	0.000
At 34,600 lb:	920 nm	920 nm	0.000

3. Program Data

The following pages are a reproduction of the input data used for VASCOMP and the output of the program for the calibration runs. Two missions were flown. The first mission was flown at a gross weight of 43,800 pounds to properly size the aircraft. This mission was based on the US Marine Corps requirement for the V-22, in the medium assault transport role, to have the capability to carry 24 troops plus equipment on a mission radius of 200 nautical miles. The second mission was representative of the US Navy requirement for the V-22, in the combat search and rescue role, to be able to fly a 460 nautical mile radius to rescue four people.

```
DATE 11/25/85  JVX - 25 PASSENGER TILT ROTOR                          PAGE  1

                              V A S C O M P   I I

       V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

"LOC. " = LOCATION NUMBER GIVEN ON INPUT SHEET
"NUM  " = NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX OF 5)
"VAL  " = VALUE FOR VARIABLE CORRESPONDING TO LOC.
"VAL1" = VALUE FOR VARIABLE CORRESPONDING TO LOC.+0001
"VAL2" = VALUE FOR VARIABLE CORRESPONDING TO LOC.+0002
"VAL3" = VALUE FOR VARIABLE CORRESPONDING TO LOC.+0003
      ETC.

LOC. NUM     VAL           VAL1          VAL2          VAL3          VAL4

  1  5      1.000        0.0000E+00    0.0000E+00     1.000         4.000
  6  5      2.000         2.000         1.000         1.000        0.0000E+00
 11  3     0.0000E+00    0.0000E+00    0.0000E+00
 14  5     0.4380E+05    0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00
 19  5      1.000        0.6000         260.0         300.0         3.000
 24  3      1.000        0.0000E+00     1.023
 96  2      5.000         30.00
103  5      3.000        0.2230        0.2230         100.0        -6.500
108  5      1.000         4.000         1.000         36.40        0.1500
113  4      1.200        0.6000         50.25        0.8000E-01
117  3     11.40         0.0000E+00     1.000
126  1     0.0000E+00
129  4      1.500         33.00        0.1000        0.1230
133  4     0.7000         50.50        0.0000E+00     1.000
151  3      1.000        0.0000E+00    0.0000E+00
159  5      1.000        0.0000E+00     25.00         2.000         1.000
164  5     20.00          37.00         16.00         4.000        0.1000E-05
201  2      1.650         9710.
204  1      2.000
206  3     0.9700        0.0000E+00     1.080
210  1      1.105
213  5      2.000        0.2000E+05     260.0        0.0000E+00     1.098
223  4      2.000         775.0         19.30         38.00
200  1      2.000
227  4     0.1300         67.00         3.000        0.2500
234  1     0.7500
305  1     0.1500E-01
```

```
 307  2      10.50          2.000
 312  2      1.000          1.000
 330  5    0.2000E+07       6.280        -1.000         0.3000        0.3500
 317  2    0.0000E+00       4.000
 335  2    0.0000E+00     0.0000E+00
 400  4    0.2686E+05      6280.          2410.        0.1000E+05
 480  3    0.0000E+00      238.0          10.00
 483  3    0.1000           3.250         1382.
 487  5      10.00          1.230         388.5        0.3770E-01      15.00
 492  4    0.0000E+00     0.1000E-04    0.1000E-04      50.00
 496  4    0.1000E-04     0.1000E-04    0.1000E-04     0.2400E-01
 404  5      19.20        0.1000E-01    0.0000E+00     0.0000E+00    0.1620E-01
 409  1    0.4323
 420  1     160.8
 422  5    0.3500E-01     0.8000          1.000         0.6000        180.0
 427  3    0.1700         0.3200        0.3422
 450  1      5.000
 453  2     275.3         0.1300
 456  3    0.1800          15.77          1.000
 394  1      4.000
 396  4     61.00         0.1200          48.00          2.200
 142  1    0.2500
 257  3    0.0000E+00       1.000         30.00
 260  2      1.000          500.0
 263  1    0.5000E-01
  94  1      1.000
  98  1      2.000
 123  2      1.250          2.500

         ECONOMICS  INPUT
  99  1    0.0000E+00
1675  5      3.620          1.100       0.0000E+00      350.0       0.0000E+00
1680  4    0.0000E+00     0.0000E+00    0.0000E+00     0.5600E+05
1684  5    0.1492          3.000        0.1500E-01      15.00         5000.
1680  5     5000.          1.000        0.0000E+00      12.00        0.1500
1694  2     2800.          10.00

         G.E.  T64 ENGINE DATA
 139  3    0.5000E-01     0.0000E+00    0.2600
1201  5      1.000          1.000       0.0000E+00       2.000      0.0000E+00
1220  2      1.005          1.060
1223  1    0.9170
1301  5      1.650        0.0000E+00      712.0        0.0000E+00     1200.
1306  5     1270.          1745.          1820.          1850.        7.000
1311  5     1200.          1400.          1600.          1800.        1900.
1316  2     2000.          2200.
1319  1      5.000
1320  5    0.0000E+00     0.2000         0.4000         0.6000        0.8000
```

```
1326  5    0.8000E-01    0.7500E-01    0.6600E-01    0.5000E-01    0.1500E-01
1332  5    0.3390        0.3340        0.3300        0.3200        0.2910
1338  5    0.6120        0.6230        0.6330        0.6350        0.6300
1344  5    0.9260        0.9520        0.9800         1.000         1.016
1350  5     1.082         1.118         1.153         1.188         1.215
1356  5     1.245         1.288         1.330         1.375         1.415
1362  5     1.570         1.625         1.680         1.740         1.805
1374  1     7.000
1375  5     1200.         1400.         1600.         1800.         1900.
1380  2     2000.         2200.
1383  1     5.000
1384  5    0.0000E+00    0.2000        0.4000        0.6000        0.8000
1390  5    0.9700E-01    0.1000        0.1050        0.1100        0.1200
1396  5    0.2000        0.2030        0.2080        0.2160        0.2260
1402  5    0.3050        0.3110        0.3200        0.3310        0.3450
1408  5    0.4230        0.4330        0.4470        0.4600        0.4800
1414  5    0.4850        0.4980        0.5140        0.5320        0.5530
1420  5    0.5470        0.5670        0.5840        0.6030        0.6280
1426  5    0.6780        0.7030        0.7240        0.7490        0.7770
1438  5     7.000         1200.         1400.         1600.         1800.
1443  3     1900.         2000.         2200.
1447  1     5.000
1448  5    0.0000E+00    0.2000        0.4000        0.6000        0.8000
1454  5    0.6440        0.6510        0.6580        0.6650        0.6750
1460  5    0.8800        0.8830        0.8890        0.8980        0.9100
1466  5    0.9380        0.9390        0.9420        0.9480        0.9570
1472  5    0.9880        0.9910        0.9920        0.9960         1.002
1478  5     1.008         1.010         1.014         1.020         1.025
1484  5     1.025         1.027         1.032         1.039         1.046
1490  5     1.059         1.062         1.066         1.073         1.083
1502  5     7.000         1200.         1400.         1600.         1800.
1507  3     1900.         2000.         2200.
1511  5     5.000        0.0000E+00    0.2000        0.4000        0.6000
1516  1    0.8000
1518  5    0.5060        0.5060        0.5060        0.5060        0.5060
1524  5    0.6860        0.6860        0.6860        0.6860        0.6860
1530  5    0.8500        0.8500        0.8500        0.8500        0.8500
1536  5    0.9740        0.9740        0.9740        0.9740        0.9740
1542  5     1.023         1.023         1.023         1.023         1.023
1548  5     1.068         1.068         1.068         1.068         1.068
1554  5     1.151         1.151         1.151         1.151         1.151

         FLIGHT MISSION PROFILE
  27  5     1.000         2.000         3.000         4.000         5.000
  32  5     2.000         1.000         9.000         6.000        0.0000E+00
  37  5     8.000         1.000         2.000         3.000         4.000
  42  5     5.000         2.000         1.000         9.000         6.000
  47  1     100.0
```

```
 501  4      0.0000E+00      0.0000E+00      0.0000E+00      0.0000E+00
 511  4      0.2500E-01      0.2500E-01      0.2500E-01      0.2500E-01
 541  4      0.7850          0.7850          0.7850          0.7850
 601  4       3.000           3.000           3.000           3.000
 611  4      0.0000E+00      0.0000E+00      0.0000E+00      0.0000E+00
 621  4       1.000           1.000           1.000           1.000
 661  4      0.1667E-01      0.1667E-01      0.1667E-01      0.1667E-01
 671  4       1.105           1.105           1.105           1.105
 681  4      0.1667E-01      0.1667E-01      0.1667E-01      0.1667E-01
 691  2       1.000           1.000
 711  2      0.0000E+00      0.0000E+00
 721  2       1000.           1000.
 741  2       3000.           7000.
 751  2       1.000           1.000
 761  2       20.00           20.00
 771  2      0.7850          0.7850
 801  2       1.000           3.000
 811  2      0.0000E+00      0.0000E+00
 821  2      0.0000E+00      0.0000E+00
 831  2       50.00           50.00
 851  2       400.0           920.0
 861  2       2.000           2.000
 881  2       1.000          0.7850
 901  2       1.000           1.000
 921  2      0.0000E+00      0.0000E+00
 931  2      -20.00          -20.00
 951  2       1000.           1000.
 961  2       400.0           920.0
 971  2      0.0000E+00      0.0000E+00
 981  2      0.7850          0.7850
1001  2       2.000           2.000
1011  2      0.1000          0.1000
1021  2      0.0000E+00      0.0000E+00
1031  2      0.3330          0.3330
1061  2      0.7850          0.7850
1111  2       3000.           7000.
1131  1      -9200.
1141  1      0.3330E-01
 139  3      0.7580E-01      0.0000E+00      0.2500
 100  1       1.000
```

```
DATE 11/25/85   JVX - 25 PASSENGER TILT ROTOR                              PAGE  2

                                   V A S C O M P   II

              V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

S I Z E   D A T A   THIS RUN CONVERGED IN  1 ITERATION(S)

                              GROSS WEIGHT =  43800.   LB

    FUSELAGE
        LF              LENGTH                                   56.6      FT
        WF              WIDTH                                     6.6      FT
        SF              WETTED AREA                            1026.       SQFT
    WING
        AR              ASPECT RATIO                              5.57
        SW              AREA                                    438.0      SQFT
        B               SPAN                                     49.4      FT
        CBARW           GEOM.  MEAN CHORD                         8.9      FT
        LAMBDA C        QUARTER CHORD SWEEP                      -6.5      DEG
        LAMBDA          TAPER RATIO                              1.000
        (T/C)R          ROOT THICKNESS                           0.223
        (T/C)T          TIP  THICKNESS                           0.223
        WG/SW           WING LOADING                            100.0      LB/SQFT
        C BAR / D       MEAN CHORD / PROP. DIA.                  0.233
    HOR.  TAIL
        ARHT            ASPECT RATIO                              4.00
        SHT             AREA                                    128.0      SQFT
        BHT             SPAN                                     22.6      FT
        CBARHT          MEAN CHORD                                5.8      FT
        (T/C)HT         THICKNESS / CHORD                        0.150
        ELTH            MOMENT ARM                               36.4      FT
        VBARH           VOLUME COEF.                             1.200
    VERT.  TAIL
        ARVT            ASPECT RATIO                              1.50
        SVT             AREA                                     80.7      SQFT
        BVT             SPAN                                     11.0      FT
        CBARVT          MEAN CHORD                                7.4      FT
        (T/C)VT         THICKNESS / CHORD                        0.100
        ELTV            MOMENT ARM                               33.0      FT
        VBARV           VOLUME COEF.                             0.123
    PRIMARY ENG.  NACELLE
        LN              LENGTH                                   17.4      FT
        DBARN           MEAN DIAMETER                             5.3      FT
        SN              WETTED AREA                             578.1      SQFT
    LIFT ENG.  NACELLE
                        NO LIFT PROPULSION SELECTED
```

```
PROPELLER
    D               DIAMETER                                38.0     FT
    SIGMA R/P       SOLIDITY                                0.109
    WG/A            DISC LOADING                            19.3     LB/SQFT
    CT/SIGMA        THRUST COEFF. / SOLIDITY                0.130
    NR              NO. OF PROPELLERS                       2.000
    NO. BLADES      NO. OF BLADES/PROP                      3.000
    SR              BLADE CUTOUT / RADIUS RATIO             0.080
    VT              TIPSPEED                                775.0    FT/SEC
```

```
DATE 11/25/85   JVX - 25 PASSENGER TILT ROTOR                              PAGE  3

                                  V A S C O M P  II

         V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

P A S S E N G E R  S I Z I N G  D A T A

                              TOURIST                FIRST CLASS
                              -------                -----------
         NO.  OF PASS.         25.                      0.
         NO.  ABREAST           2.                      0.
         NO.OF AISLES           1.                      0.
         UNIT SEAT WIDTH       20.  IN.                 0.  IN.
         SEAT PITCH            37.  IN.                 0.  IN.
         AISLE WIDTH           16.  IN.                 0.  IN.

         NUMBER OF LAVATORIES           0.00
         GALLEY AREA                    0.0 SQ. FT.
         CLOSET AREA                    1.7 SQ. FT.
         CABIN DIAMETER                74.5 IN.     *** TOURIST CLASS CRITICAL
         BODY DIAMETER                 79.3 IN.     *** TOURIST CLASS CRITICAL

         NOSE SECTION LENGTH            8.3 FT.
         TAIL SECTION LENGTH           16.5 FT.
         CONST. DIA. LENGTH            31.8 FT.

           TOTAL FUSELAGE LENGTH           56.6 FT.
```

```
DATE 11/25/85  JVX - 25 PASSENGER TILT ROTOR                              PAGE  4

                                          V A S C O M P  II

                V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM     B-93

W E I G H T S  D A T A    IN LBS

               EMLF           MANEUVER LOAD FACTOR                        3.000
               GLF            GUST LOAD     FACTOR                        2.096
               ULF            ULTIMATE LOAD FACTOR                        4.500

           STRUCTURES GROUP
               K8  WW         WING                                        2192.
               K9  WHT        HOR.  TAIL                                   360.
               K10 WVT        VERT.  TAIL                                  407.
               K11 WB         FUSELAGE                                    4028.
               K12 WLG        LANDING GEAR                                1533.
               K13 WLES       LIFT ENGINE SECTION                            0.
               K14 WPES       PRIMARY ENGINE SECTION                       487.
               SPACE5(2)      PRIMARY ENGINE ACOUSTIC TREAT.                 0.
               DELTA WST      STRUCTURE WEIGHT INCREMENT                     0.
               WST            TOTAL STRUCTURE WEIGHT                      9008.
           PROPULSION GROUP
               K2  WR/P       ROTOR OR PROP                               2940.
               K3  WDS        DRIVE SYSTEM                                3852.
               K4  WEL        LIFT ENGINES                                   0.
               K5  WEP        PRIMARY ENGINES                             1424.
               K6  WLEI       LIFT ENGINE INSTALLATION                       0.
               K7  WPEI       PRIMARY ENGINE INSTALLATION                  256.
               K21 WFS        FUEL SYSTEM                                  589.
               DELTA WP       PROPULSION GROUP WEIGHT INCREMENT              0.
               WP             TOTAL PROPULSION GROUP WEIGHT               9062.

           FLIGHT CONTROLS GROUP
               K15 WCC        COCKPIT CONTROLS                              90.
               K16 WUC        UPPER   CONTROLS                            1271.
               K17 WH         HYDRAULICS                                     0.
               K18 WFW        FIXED WING CONTROLS                          438.
               K19 WSAS       SAS                                            0.
               K20 WTM        TILT MECHANISM                               710.
               DELTA WFC      CONTROL WEIGHT INCREMENT                       0.
               WFC            TOTAL CONTROL WEIGHT                        2509.
```

WFE	WEIGHT OF FIXED EQUIPMENT	6280.
WE	WEIGHT EMPTY	26858.
WFUL	FIXED USEFUL LOAD	2410.
OWE	OPERATING WEIGHT EMPTY	29268.
WPL	PAYLOAD	10000.
(WF)A (WF)W	FUEL	4532. 4532.
WG	GROSS WEIGHT	43800.

```
DATE 11/25/85  JVX - 25 PASSENGER TILT ROTOR                          PAGE  5

                                   V A S C O M P  II
        V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
P R O P U L S I O N  D A T A
    PRIMARY PROPULSION CYCLE NO.    1.650
        TURBOSHAFT ENGINE
         2.  ENGINES
        BHP*P  MAX. STANDARD S.L. STATIC H.P.     9710.  H.P.
        POWER LOADING = 0.2217
        ENGINE SIZE WAS FIXED BY INPUT

    ACCESSORY HORSEPOWER EXTRACTED =   30.00  H.P.

    NO LIFT ENGINE CYCLE SELECTED
    XMSN SIZED AT 100.  PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
    (MAX. STANDARD S.L.  STATIC H.P.),100.0 PERCENT HOVER RPM

    TRANSMISSION EFFICIENCY = 0.9700
```

```
 DATE 11/25/85  JVX - 25 PASSENGER TILT ROTOR                         PAGE  6

                               V A S C O M P  II

         V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

A E R O D Y N A M I C S  D A T A
         FE             TOTAL EFFECTIVE FLATPLATE AREA      13.862  SQFT
         SWET           TOTAL WETTED AREA                    2839.  SQFT
         CBARF          MEAN SKIN FRICTION COEFF.         0.004883

D R A G  B R E A K D O W N          IN  SQFT
         FEW            WING FE                              0.000
         FEF            FUSELAGE FE                          7.292
         FEVT           VERT. TAIL FE                        0.000
         FEHT           HOR.  TAIL FE                        0.000
         FEN            PRIMARY ENG. NACELLE FE              0.000
         FELN           LIFT ENG. NACELLE FE                 0.000
         DELTA FE       INCREMENTAL FE                       6.570

A E R O D Y N A M I C  C O E F F .
         A1                                                0.59515
         A2                                               -0.11302
         A3                                                0.12091
         A4                                                0.16725
         A5                                                0.03165
         A6                                                0.91323
         A7                                                0.07185
         CL ALPHA       3-D LIFT SLOPE                     4.85981 PER RADIAN
         E              OSWALD   FACTOR                       0.79479
```

```
DATE 11/25/85  JVX - 25 PASSENGER TILT ROTOR                         PAGE  7

                              V A S C O M P  II
                 V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
                      M I S S I O N   P E R F O R M A N C E   D A T A

TAXI FOR 0.025 HRS AT GROUND IDLE ENGINE RATING; TEMPERATURE =  59.0 DEG.F

               FUEL              PRES          TURB ENG  PETF
TIME    RNG   USED   WEIGHT   ALT     TAS    TEMP CODE  OR    LETF
(HRS)  (NM)  (LB)    (LB)     (FT)   (KT)   (R)         PEHF
0.000   0.0     0.  43800.      0.     0.   1200.  T    0.071 0.000
0.025   0.0    24.  43776.      0.     0.   1200.  T    0.071 0.000

TAKEOFF, HOVER, OR LAND AT PETF = 1.000  LETF = 0.000 FOR  0.017 HRS.
VERTICAL RATE OF CLIMB =    0.0 FT/MIN                TEMPERATURE =  59.0 DEG.F

               FUEL              PRES          TURB ENG  PETF         THRUST
TIME    RNG   USED   WEIGHT   ALT     TAS    TEMP CODE  OR    LETF    TO     FM     CT
(HRS)  (NM)  (LB)    (LB)     (FT)   (KT)   (R)         PEHF        WEIGHT
0.025   0.0    24.  43776.      0.     0.   1850.  T    1.000 0.000 1.143 0.708 0.1166
0.042   0.0    99.  43701.      0.     0.   1850.  T    1.000 0.000 1.145 0.708 0.1166

CLIMB  TO  3000.  FT. WITH   MAXIMUM R/C  AT MILITARY  ENGINE RATING

               FUEL              PRES          TURB ENG  PETF                 MACH        THETA
TIME   RNG    USED   WEIGHT   ALT     TAS    TEMP CODE  OR    EAS     MACH  DIV    R/C     F
(HRS) (NM)   (LB)    (LB)     (FT)   (KT)   (R)         PEHF                       (FPM)(DEG)
0.042    0.0    99.  43701.      0.  177.   1820.  T    0.987 177.3 .268 .492 4118.  20.0
0.046    0.7   117.  43683.   1000.  176.   1820.  T    0.966 173.9 .268 .488 3965.  20.0
0.050    1.4   136.  43664.   2000.  176.   1820.  T    0.959 170.8 .268 .484 3828.  20.0
0.054    2.2   154.  43646.   3000.  177.   1820.  T    0.960 169.8 .271 .482 3571.  19.2

CRUISE AT   NORMAL   ENGINE RATING         TEMPERATURE =  48.3 DEG.F

               FUEL              PRES          TURB ENG PETF                MACH  SPEC    ETAP
TIME   RNG    USED   WEIGHT   ALT     TAS    TEMP CDE   OR    EAS     MACH DIV   RANGE   PROP
(HRS) (NM)   (LB)    (LB)     (FT)   (KT)   (R)        PEHF                      (NMPP)
0.054    2.2   154.  43646.   3000.  261.   1500.  P   0.454 250.0 .399 .542 .10602 .836
0.237   50.0   606.  43194.   3000.  261.   1499.  P   0.453 250.0 .399 .543 .10620 .833
0.429  100.0  1076.  42724.   3000.  261.   1498.  P   0.452 250.0 .399 .543 .10637 .829
0.620  150.0  1546.  42254.   3000.  261.   1497.  P   0.450 250.0 .399 .544 .10653 .825
0.811  200.0  2016.  41784.   3000.  261.   1497.  P   0.450 250.0 .399 .544 .10666 .821
```

```
1.003 250.0 2484. 41315.  3000. 261.  1496.  P  0.449 250.0 .399 .545 .10678 .817
1.194 300.0 2953. 40847.  3000. 261.  1496.  P  0.448 250.0 .399 .545 .10686 .812
1.385 350.0 3421. 40379.  3000. 261.  1496.  P  0.448 250.0 .399 .546 .10692 .807
1.552 393.5 3827. 39973.  3000. 261.  1496.  P  0.448 250.0 .399 .546 .10693 .802

DESCEND TO H =     0.  FT.  ,R =   400.00 N.MI. .AT MAX.  SPEED

                FUEL             PRES          TURB ENG  PETF                 MACH         THETA
TIME   RNG      USED   WEIGHT    ALT     TAS   TEMP CODE  OR     EAS    MACH  DIV   R/S      F
(HRS) (NM)      (LB)    (LB)     (FT)   (KT)  (R)        PEHF                      (FPM) (DEG)
1.552 393.5 3827. 39973.  3000. 261.  1270.  T   0.116 250.0 .399 .547 2085.  -3.5
1.560 395.5 3838. 39962.  2000. 257.  1270.  T   0.109 250.0 .392 .547 1910.  -3.1
1.568 397.8 3850. 39950.  1000. 254.  1270.  T   0.104 250.0 .385 .547 1911.  -3.2
1.577 400.0 3862. 39938.     0. 250.  1270.  T   0.098 250.0 .378 .547 1914.  -3.3

TAKEOFF, HOVER, OR LAND AT PETF = 1.000  LETF = 0.000 FOR  0.017 HRS.
VERTICAL RATE OF CLIMB =    0.0 FT/MIN              TEMPERATURE =  59.0 DEG.F

                FUEL             PRES          TURB ENG  PETF         THRUST
TIME    RNG     USED   WEIGHT    ALT     TAS   TEMP CODE  OR    LETF   TO      FM      CT
(HRS)   (NM)    (LB)    (LB)     (FT)   (KT)  (R)        PEHF         WEIGHT
1.577 400.0 3862. 39938.     0.    0.  1850.  T   1.000 0.000 1.252 0.708 0.1166
1.594 400.0 3937. 39863.     0.    0.  1850.  T   1.000 0.000 1.255 0.708 0.1166

TAXI FOR 0.025 HRS AT GROUND IDLE ENGINE RATING; TEMPERATURE =  59.0 DEG.F

                FUEL             PRES          TURB ENG  PETF
TIME    RNG     USED   WEIGHT    ALT     TAS   TEMP CODE  OR    LETF
(HRS)   (NM)    (LB)    (LB)     (FT)   (KT)  (R)        PEHF
1.594 400.0 3937. 39863.     0.    0.  1200.  T   0.071 0.000
1.619 400.0 3961. 39839.     0.    0.  1200.  T   0.071 0.000

      TRANSFER ALTITUDE TO    3000.  FT.

                                FUEL                    PRES.
       TIME       RANGE         USED       WEIGHT       ALT.
       (HRS)      (N.M.)        (LBS)      (LBS.)       (FT)
       1.619       400.00       3961.2      39839.          0.
       1.619       400.00       3961.2      39839.       3000.
```

```
LOITER FOR  0.333 HRS. FOR RESERVE FUEL     TEMPERATURE=   48.3 DEG.F

                FUEL              PRES         TURB ENG PETF                  MACH   FUEL   ETAP
TIME   RNG      USED    WEIGHT    ALT     TAS  TEMP CDE  OR     EAS   MACH    DIV   RATE   PROP
(HRS)  (NM)     (LB)     (LB)     (FT)   (KT)  (R)      PEHF                        (LB-HR)
1.619  400.0  3961.   39839.    3000.  162.  1360.  P  0.311  155.1  .248  .469   1738.  .824
1.719  400.0  4135.   39665.    3000.  160.  1358.  P  0.309  153.2  .245  .467   1730.  .824
1.819  400.0  4308.   39492.    3000.  159.  1357.  P  0.307  152.3  .243  .466   1723.  .824
1.919  400.0  4480.   39320.    3000.  157.  1355.  P  0.305  150.4  .240  .463   1715.  .824
1.952  400.0  4537.   39263.    3000.  157.  1355.  P  0.305  150.4  .240  .463   1714.  .824

                    MISSION FUEL REQUIRED =  3961.14
                    RESERVE FUEL REQUIRED =   575.79
                    TOTAL   FUEL REQUIRED =  4536.92
```

```
DATE 11/25/85  JVX - 25 PASSENGER TILT ROTOR                               PAGE  8

                               V A S C O M P  II
            V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
                  M I S S I O N   P E R F O R M A N C E   D A T A


    CHANGE PAYLOAD,   REMOVE    9200.   LB.

                             FUEL                    PRES.
     TIME       RANGE        USED       WEIGHT       ALT.
     (HRS)      (N.M.)       (LBS)      (LBS.)       (FT)
     0.000         0.00         0.0      43800.         0.
     0.033         0.00         0.0      34600.         0.

TAXI FOR 0.025 HRS AT GROUND IDLE ENGINE RATING; TEMPERATURE =  59.0 DEG.F

            FUEL              PRES          TURB ENG  PETF
TIME   RNG  USED   WEIGHT     ALT     TAS   TEMP CODE  OR    LETF
(HRS) (NM)  (LB)    (LB)      (FT)   (KT)   (R)        PEHF
0.033   0.0    0.  34600.       0.     0.  1200.  T   0.071 0.000
0.058   0.0   24.  34576.       0.     0.  1200.  T   0.071 0.000

TAKEOFF, HOVER, OR LAND AT PETF = 1.000  LETF = 0.000 FOR  0.017 HRS.
VERTICAL RATE OF CLIMB =     0.0 FT/MIN             TEMPERATURE =  59.0 DEG.F

            FUEL              PRES          TURB ENG  PETF        THRUST
TIME   RNG  USED   WEIGHT     ALT     TAS   TEMP CODE  OR    LETF   TO     FM     CT
(HRS) (NM)  (LB)    (LB)      (FT)   (KT)   (R)        PEHF        WEIGHT
0.058   0.0   24.  34576.       0.     0.  1850.  T   1.000 0.000 1.447 0.708 0.1166
0.075   0.0   99.  34501.       0.     0.  1850.  T   1.000 0.000 1.450 0.708 0.1166

CLIMB  TO  7000.   FT. WITH   MAXIMUM R/C  AT MILITARY  ENGINE RATING

            FUEL              PRES          TURB ENG  PETF                 MACH        THETA
TIME  RNG   USED   WEIGHT     ALT     TAS   TEMP CODE  OR    EAS    MACH  DIV    R/C     F
(HRS) (NM)  (LB)    (LB)      (FT)   (KT)   (R)        PEHF                     (FPM)(DEG)
0.075   0.0   99.  34501.       0.   192.  1820.  T   0.991 192.0 .290  .527 5654.  20.0
0.078   0.5  112.  34488.    1000.   191.  1820.  T   0.969 188.4 .290  .524 5536.  20.0
0.081   1.1  126.  34474.    2000.   190.  1820.  T   0.959 184.8 .290  .521 5415.  20.0
0.084   1.7  139.  34461.    3000.   189.  1820.  T   0.960 181.2 .289  .518 5290.  20.0
0.087   2.2  152.  34448.    4000.   189.  1820.  T   0.960 177.7 .289  .515 5159.  20.0
0.090   2.8  165.  34435.    5000.   188.  1820.  T   0.960 174.3 .289  .512 5025.  20.0
0.094   3.4  179.  34421.    6000.   187.  1820.  T   0.960 170.8 .288  .508 4885.  20.0
```

```
0.097   4.0  192. 34408.  7000. 186. 1820. T   0.961 167.1 .288 .504 4720.  20.0

CRUISE AT BEST RANGE SPEED WITH HEADWIND OF   0.0 KNOTS    TEMP =  34.0 DEG.F

              FUEL             PRES        TURB ENG PETF                 MACH SPEC   ETAP
TIME   RNG    USED   WEIGHT    ALT    TAS  TEMP CDE  OR    EAS   MACH DIV  RANGE  PROP
(HRS) (NM)   (LB)    (LB)     (FT)   (KT) (R)       PEHF                   (NMPP)
0.097   4.0  192.  34408.   7000.  240. 1376.  P  0.353 215.8 .371 .539 .13868 .910
0.289  50.0  524.  34076.   7000.  240. 1374.  P  0.349 215.8 .371 .539 .13950 .912
0.498 100.0  882.  33718.   7000.  240. 1371.  P  0.346 215.8 .371 .540 .14036 .914
0.706 150.0 1238.  33362.   7000.  240. 1369.  P  0.343 215.8 .371 .541 .14118 .915
0.915 200.0 1592.  33008.   7000.  239. 1365.  P  0.338 214.9 .370 .541 .14196 .916
1.124 250.0 1945.  32655.   7000.  237. 1361.  P  0.332 213.1 .367 .540 .14230 .916
1.336 300.0 2296.  32304.   7000.  237. 1358.  P  0.329 213.1 .367 .541 .14311 .916
1.547 350.0 2645.  31955.   7000.  237. 1356.  P  0.326 213.1 .367 .542 .14388 .917
1.758 400.0 2993.  31607.   7000.  238. 1356.  P  0.326 214.0 .368 .543 .14462 .918
1.968 450.0 3339.  31261.   7000.  237. 1352.  P  0.321 213.1 .367 .543 .14531 .917
2.180 500.0 3683.  30917.   7000.  237. 1351.  P  0.319 213.1 .367 .543 .14598 .917
2.391 550.0 4025.  30575.   7000.  238. 1351.  P  0.318 214.0 .368 .544 .14661 .917
2.601 600.0 4366.  30234.   7000.  238. 1349.  P  0.316 214.0 .368 .545 .14719 .916
2.812 650.0 4706.  29894.   7000.  238. 1347.  P  0.314 214.0 .368 .545 .14775 .915
3.022 700.0 5044.  29556.   7000.  239. 1348.  P  0.314 214.9 .370 .546 .14828 .915
3.232 750.0 5382.  29218.   7000.  239. 1346.  P  0.313 214.9 .370 .547 .14877 .914
3.441 800.0 5718.  28882.   7000.  235. 1340.  P  0.304 211.3 .363 .546 .14890 .911
3.654 850.0 6053.  28547.   7000.  233. 1335.  P  0.297 209.5 .360 .546 .14974 .906
3.869 900.0 6387.  28213.   7000.  229. 1329.  P  0.290 205.9 .354 .544 .14998 .902
3.885 903.5 6411.  28189.   7000.  229. 1329.  P  0.291 206.2 .355 .545 .15002 .903

DESCEND TO H =     0. FT.  ,R =   920.00 N.MI. AT MAX.  SPEED

              FUEL             PRES        TURB ENG   PETF                 MACH        THETA
TIME   RNG    USED   WEIGHT    ALT    TAS  TEMP CODE   OR    EAS    MACH DIV   R/S      F
(HRS) (NM)   (LB)    (LB)     (FT)   (KT) (R)         PEHF                   (FPM)  (DEG)
3.885 903.5 6411.  28189.   7000.  278. 1270.  T    0.204 250.0 .430 .561 2086.  -4.7
3.893 905.7 6421.  28179.   6000.  273. 1270.  T    0.197 250.0 .422 .561 1868.  -4.3
3.901 908.2 6433.  28167.   5000.  269. 1270.  T    0.189 250.0 .414 .561 1854.  -4.3
3.910 910.6 6445.  28155.   4000.  265. 1270.  T    0.181 250.0 .407 .561 1844.  -4.4
3.919 913.0 6457.  28143.   3000.  261. 1270.  T    0.172 250.0 .399 .561 1837.  -4.4
3.929 915.4 6469.  28131.   2000.  257. 1270.  T    0.165 250.0 .392 .561 1832.  -4.5
3.938 917.7 6482.  28118.   1000.  254. 1270.  T    0.160 250.0 .385 .561 1832.  -4.5
3.947 920.0 6494.  28106.      0.  250. 1270.  T    0.155 250.0 .378 .561 1836.  -4.6

TAKEOFF, HOVER, OR LAND AT PETF = 1.000  LETF = 0.000 FOR  0.017 HRS.
VERTICAL RATE OF CLIMB =     0.0 FT/MIN             TEMPERATURE =  59.0 DEG.F

              FUEL             PRES        TURB ENG   PETF         THRUST
TIME    RNG   USED   WEIGHT    ALT    TAS  TEMP CODE   OR    LETF    TO     FM      CT
(HRS)  (NM)  (LB)    (LB)     (FT)   (KT) (R)         PEHF         WEIGHT
```

```
3.947 920.0 6494. 28106.     0.   0. 1850. T   1.000 0.000 1.780 0.708 0.1166
3.963 920.0 6569. 28030.     0.   0. 1850. T   1.000 0.000 1.784 0.708 0.1166

TAXI FOR 0.025 HRS AT GROUND IDLE ENGINE RATING; TEMPERATURE =  59.0 DEG.F

            FUEL          PRES       TURB ENG  PETF
TIME   RNG  USED  WEIGHT  ALT   TAS  TEMP CODE  OR   LETF
(HRS) (NM) (LB)   (LB)   (FT)  (KT) (R)        PEHF
3.963 920.0 6569. 28030.     0.   0. 1200. T   0.071 0.000
3.988 920.0 6594. 28006.     0.   0. 1200. T   0.071 0.000

      TRANSFER ALTITUDE TO    7000. FT.

                           FUEL                 PRES.
       TIME     RANGE      USED       WEIGHT     ALT.
       (HRS)    (N.M. )    (LBS)      (LBS. )    (FT)
       3.988     920.00    6593.5      28006.        0.
       3.988     920.00    6593.5      28006.     7000.

LOITER FOR  0.333 HRS. FOR RESERVE FUEL     TEMPERATURE=   34.0 DEG.F

            FUEL          PRES       TURB ENG PETF             MACH  FUEL  ETAP
TIME  RNG   USED  WEIGHT  ALT   TAS  TEMP CDE  OR    EAS  MACH  DIV  RATE  PROP
(HRS) (NM)  (LB)   (LB)   (FT)   (KT) (R)     PEHF                  (LB-HR)
3.988 920.0 6594. 28006.  7000. 149. 1260. P  0.207 134.1 .231 .477  1225. .856
4.088 920.0 6716. 27884.  7000. 149. 1259. P  0.206 134.1 .231 .477  1220. .856
4.188 920.0 6838. 27762.  7000. 148. 1258. P  0.205 133.2 .229 .476  1216. .855
4.288 920.0 6960. 27640.  7000. 148. 1257. P  0.203 133.2 .229 .476  1212. .856
4.321 920.0 7000. 27600.  7000. 147. 1257. P  0.203 132.3 .228 .475  1211. .855

              MISSION FUEL REQUIRED =  6593.52
              RESERVE FUEL REQUIRED =   406.16
              TOTAL   FUEL REQUIRED =  6999.68

********************************************************************************

                         END   OF   SUCCESSFUL   CASE

********************************************************************************
```

```
DATE 11/25/85   JVX - 25 PASSENGER TILT ROTOR                              PAGE  1

                                  V A S C O M P  II

              V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
                                   S U M M A R Y
                                                ITERATION NO.  =   1

GROSS WEIGHT        =     43800.               WING AREA           =     438.00
NO.PRIMARY ENGINES  =         2.               WING LOADING        =     100.00
PRIMARY THR.OR.PWR  =      9710.               SPAN                =      49.41
PRIM. T/W OR BHP/W  =    0.2217                ASPECT RATIO        =       5.57
1ST CLASS PASS.     =         0.               1/4 CHORD SWEEP     =      -6.50
TOURIST PASS.       =        25.               TAPER RATIO         =     1.0000
FUSELAGE LENGTH     =     56.59                FUSELAGE WIDTH      =       6.61
HORIZ. TAIL AREA    =       128.               VERT. TAIL AREA     =        81.
EMPTY WEIGHT        =     26858.               OPER.WEIGHT EMPTY   =     29268.
PAYLOAD WEIGHT      =     10000.               WEIGHT OF FUEL      =      4532.
TOTAL WETTED AREA   =      2839.               EFF.FLAT PL. AREA   =     13.862
MEAN S.F. COEFF.    =   0.00488                NO.OF LIFT ENGINES  =         0.
LIFT ENG. THRUST    =         0.               LIFT THRUST/GRS WT  =     0.0000
```

```
                               M I S S I O N   D A T A

                          SEG.       SEG.                SEG.
                          TIME       FUEL       ALT.     DIST
                         (MIN)      (LBS)       (FT)    (NMI)

             TAXI          1.5       24.1        0.0
             TOFF/LND      1.0       75.2        0.0
             CLIMB         0.8       55.2                 2.2
             CRUISE       89.8     3672.8     3000.0    391.3     MACH NO.  =0.399
             DESCENT       1.5       34.7                 6.5
             TOFF/LND      1.0       75.2        0.0
             TAXI          1.5       24.1        0.0

RNG= 400.NM MSN.FUEL= 3961.  RSRV.FUEL=   576.  TOT.FUEL= 4537.  BLOCK TIME=   97.

             TAXI          1.5       24.1        0.0
             TOFF/LND      1.0       75.2        0.0
             CLIMB         1.3       92.9                 4.0
             CRUISE      227.2     6218.7     7000.0    899.5     MACH NO.  =0.355
             DESCENT       3.7       83.4                16.5
             TOFF/LND      1.0       75.2        0.0
             TAXI          1.5       24.1        0.0

RNG= 920.NM MSN.FUEL= 6594.  RSRV.FUEL=   406.  TOT.FUEL= 7000.  BLOCK TIME=  239.
```

V. DESCRIPTION OF EXPERIMENTS

A. EXPERIMENT 1 - MAXIMUM RANGE

In this experiment, the 25-passenger Model 107 and the 25-passenger tilt rotor were used to examine aircraft performance for a single-leg mission. The aircraft were programmed to carry identical payloads of 5000 pounds (which represented a load of twenty-five 200 pound passengers, including baggage) and to fly identical mission profiles at an altitude of 5000 feet mean sea level (MSL). The standard flight profile used for any given "mission" followed a sequence which included:

- Taxi
- Hover/Takeoff
- Climb
- Cruise
- Descent
- Landing/Hover
- Taxi

The objective was to determine the mission range, within the maximum range capability of the CH-46F, where the performance of the tilt rotor surpassed the performance of the tandem rotor helicopter.

B. EXPERIMENT 2 - LOITER ENDURANCE

The second experiment involved comparisons between the performance capabilities of a 25-passenger tilt rotor aircraft and the 25-passenger CH-46F for missions requiring the aircraft to traverse a specified range (mission radius) and conduct a loiter mission for the maximum time permissible while maintaining sufficient fuel to return the same distance as the outbound leg (plus reserves). Payloads carried by the aircraft were 3500 pounds and the cruise segments were flown at an altitude of 5000 feet MSL. Each "mission" consisted of the following segment sequence:

* Taxi
* Hover/Takeoff
* Climb
* Cruise
* Loiter
* Cruise
* Descent
* Landing/Hover
* Taxi

The objective was to compare the capabilities of each type aircraft at given mission radius values.

C. EXPERIMENT 3 - HOVER ENDURANCE

This experiment is an extension of experiment #2 in that payload, altitude parameters, and aircraft types remained unchanged. Flight profiles were similar except that the loiter segment was replaced with a descent-hover-climb series of segments. From a performance standpoint, the difference lies in the fact that the hover flight mode is a more demanding flight mode in terms of fuel (and power) required.

The objective in conducting this experiment was to analyze the differences in aircraft capabilities for given values of mission radius.

D. EXPERIMENT 4 - ONE TILT ROTOR VS. TWO HELICOPTERS

In the fourth and final experiment, the capability of one 44-passenger tilt rotor was compared to the capability of two 25-passenger Boeing CH-46F helicopters.

In this mission scenario, the two tandem rotor aircraft, with no payload onboard, simultaneously depart from a site designated "Helipad A". Each helicopter flies a distance equal to one-half of its maximum range capability (103 NM), receives a payload increase of 4400 pounds (to simulate the boarding of 22 passengers, each weight a total of 200 pounds with baggage), and returns to the original departure site. One helicopter flies to "Helipad B" while the other travels to "Helipad C". Helipads B and C are separated by a distance designated "Leg BC".

Starting from Helipad A with no payload, the 44-passenger tilt rotor departs at the same time as the two helicopters, flies to Helipad B, picks up a 4400 pound payload, then flies to Helipad C and picks up an additional 4400 pounds. The tilt rotor completes its mission by returning to Helipad A. The standard flight profile used for this experiment was the same as that used for experiment #1.

The objective for this experiment was to find the values for Leg BC where the tilt rotor could transport the payloads over further distances more efficiently than the two helicopters.

VI. RESULTS

A. EXPERIMENT #1

1. Fig 1, Pg 86 - Fuel Required vs Range

In addition to the obvious advantage of the extended range capability (on a single fuel load) that the tilt rotor maintains over the tandem rotor helicopter, the graph on page 86 shows that for ranges of approximately 150 NM and beyond, the tilt rotor requires less fuel than the helicopter to complete the mission. It is noted that to traverse the distance covered by the tilt rotor in one fuel load the CH-46F would have to refuel three times.

2. Fig 2, Pg 87 - Time Required vs Range

For the data presented, within the single fuel load range of the tandem rotor helicopter, it can be seen that for any given range beyond approximately 75 NM the helicopter requires at least twice as much time to travel the same distance as the tilt rotor. Refueling time would further compound this disadvantage for the helicopter.

3. Fig 3, Pg 88 - Passenger-Mile per Lb of Fuel vs Range

This graph shows that at a range of just under 150 NM the tilt rotor will perform more efficiently by being able to complete more passenger miles per pound of expended fuel than the CH-46F.

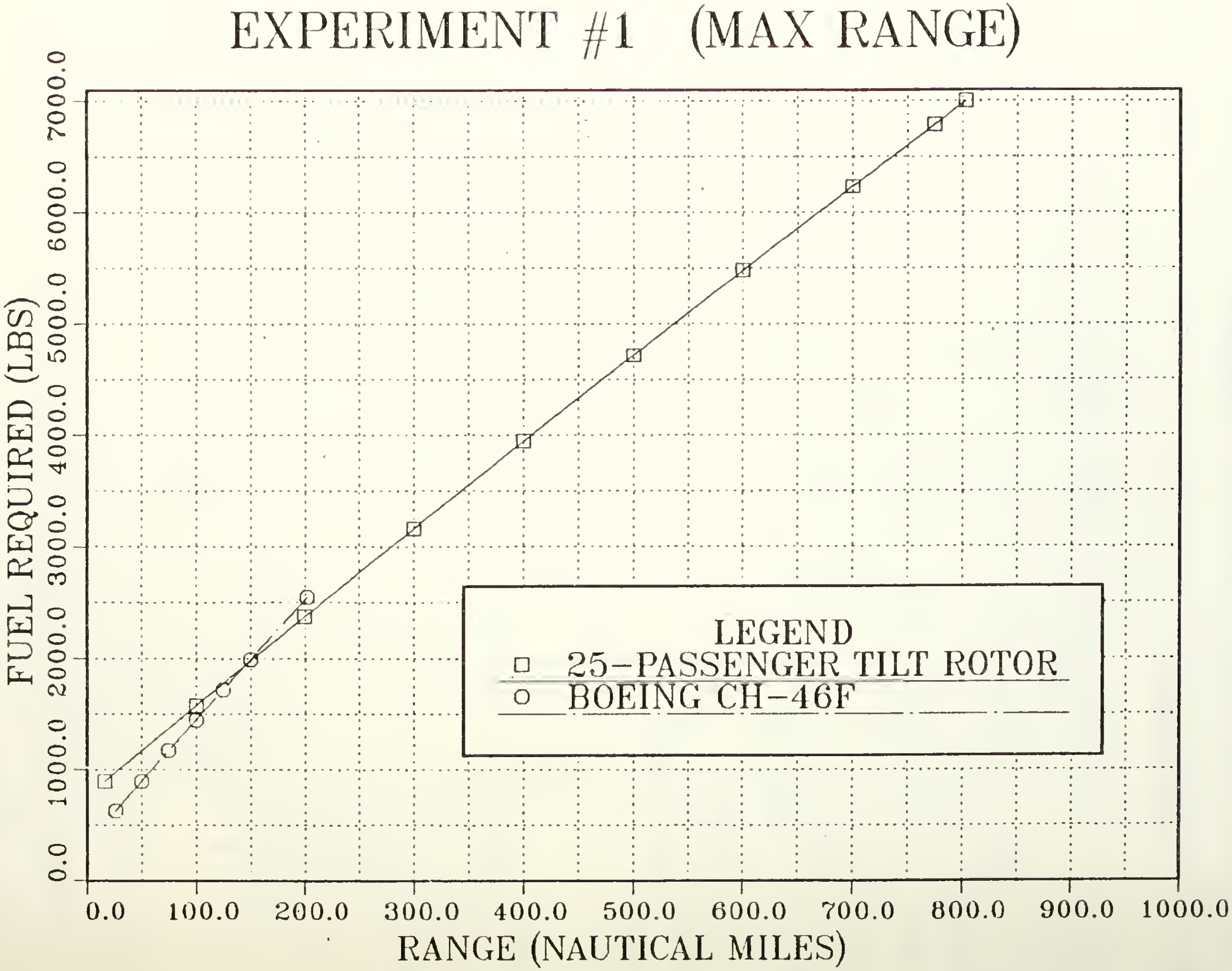

Fig 1. Fuel Required vs. Range

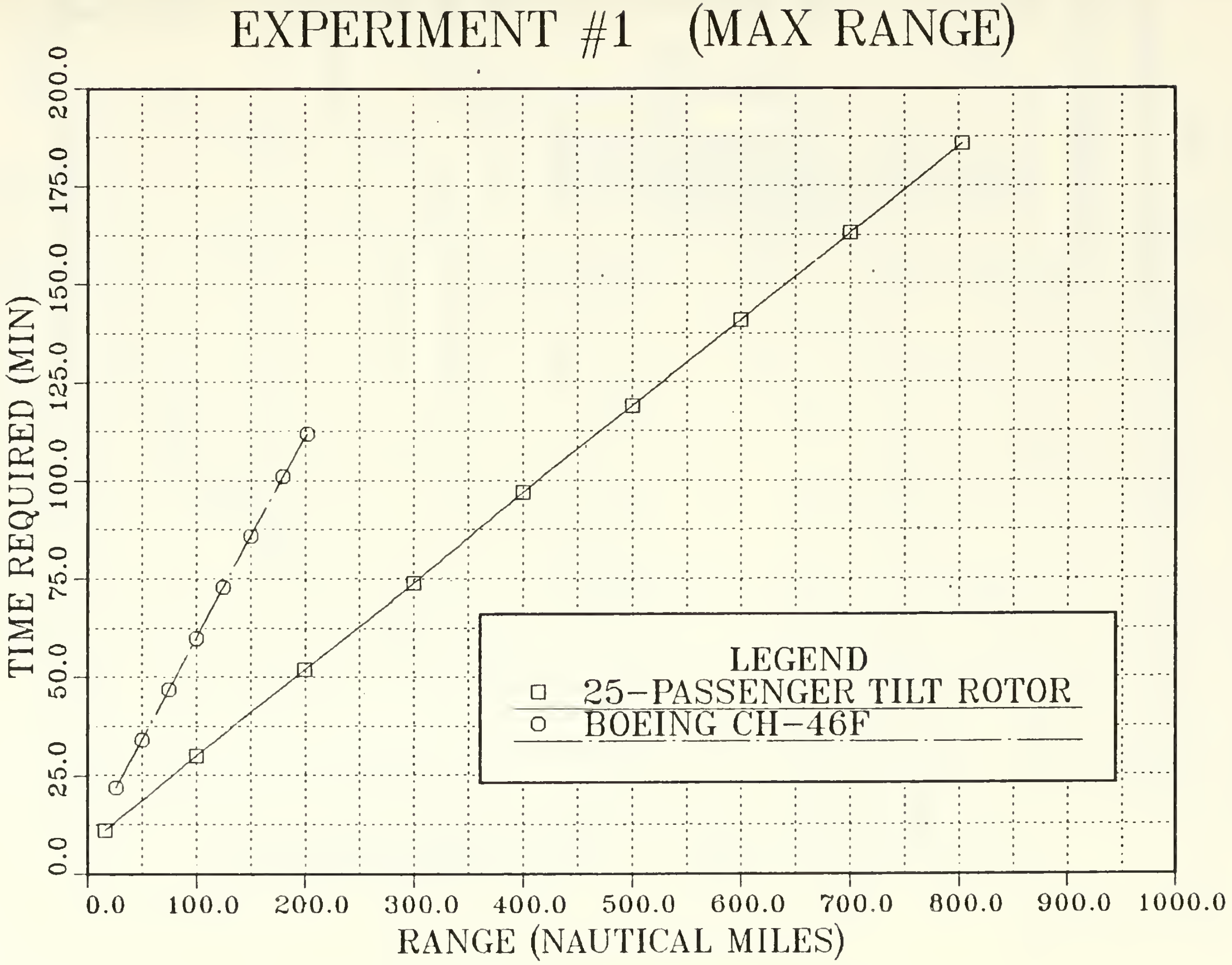

Fig 2. Time Required vs. Range

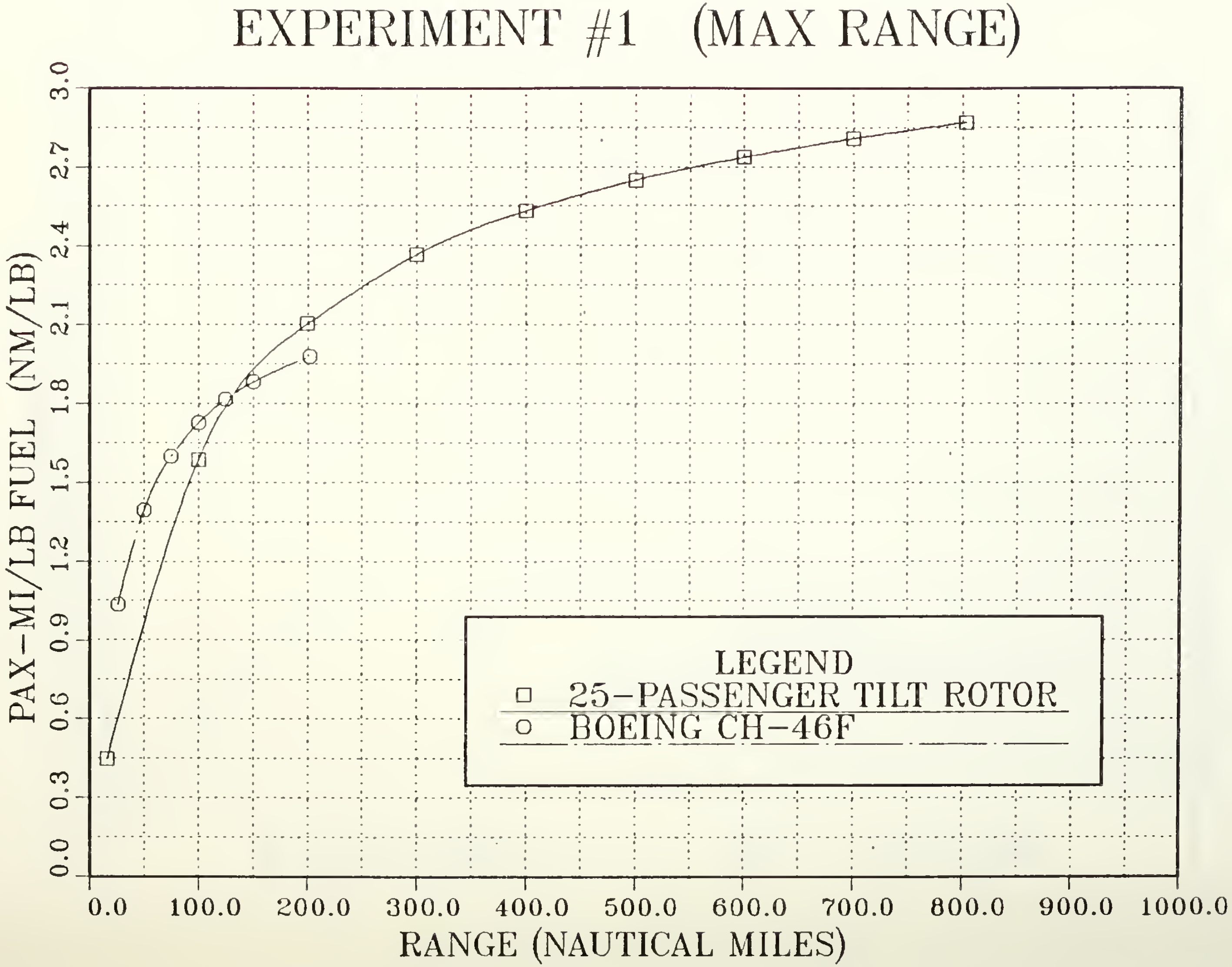

Fig 3. Pax-Mi/Lb-Fuel vs. Range

B. EXPERIMENT #2

1. Fig 4 Pg 90 - Loiter Time vs Mission Radius

The tilt rotor clearly holds a significant loiter endurance advantage over the tandem rotor helicopter. At the maximum mission radius for the CH-46F, which allows no loiter time, the tilt rotor can travel the same distance and still conduct a three hour (plus) loiter mission.

2. Fig 5, Pg 91 - Fuel Required vs Loiter Time

The graph reveals the tilt rotor's disadvantage of requiring roughly 50% more fuel than the helicopter for the same amount of loiter time.

C. EXPERIMENT #3

1. Fig 6, Pg 92 - Hover Time vs Mission Radius

Compared to the loiter mission, the tilt rotor does not maintain as large a margin of superiority for the hover mission. At the maximum mission radius for the CH-46F, (no hover time capability) the tilt rotor has sufficient remaining fuel for a little over one hour of hover time.

2. Fig 7, Pg 93 - Fuel Required vs Hover Time

The hovering efficiency of rotary wing aircraft is made apparent by this graph which shows that the tilt rotor, for a given hover time requires roughly 2.7 times more fuel than the tandem rotor helicopter.

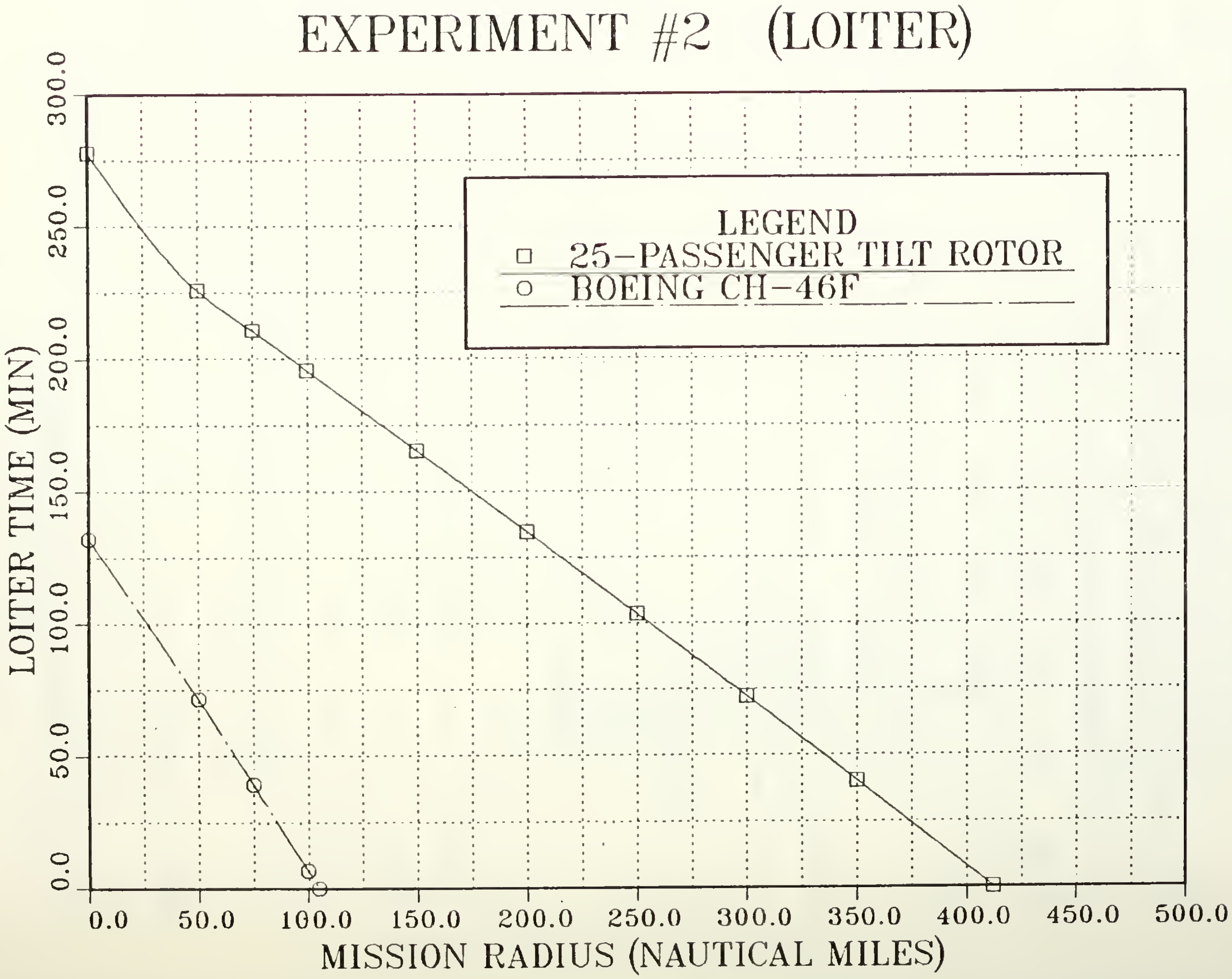

Fig 4. Loiter Time vs. Mission Radius

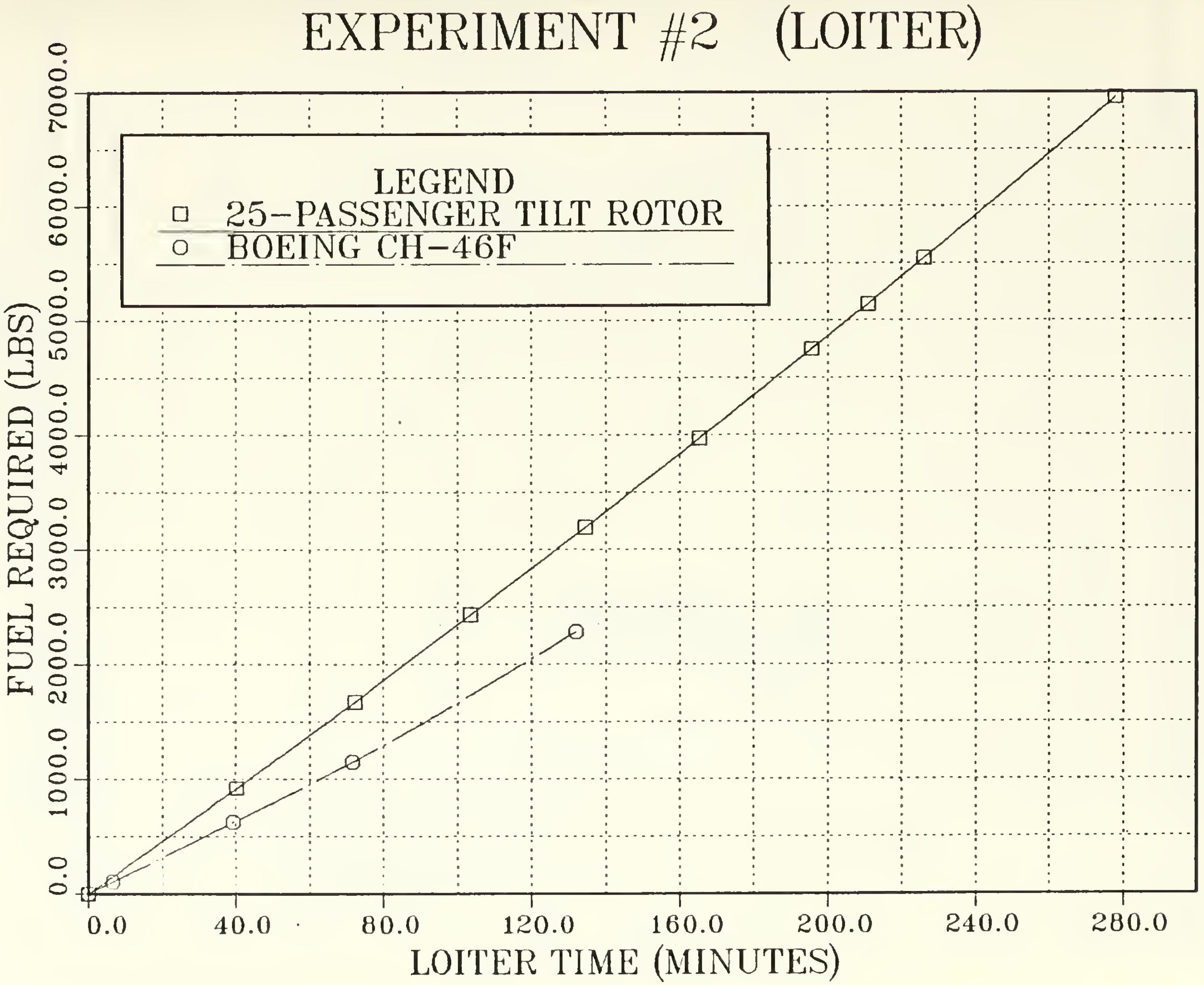

Fig 5. Fuel Required vs. Loiter Time

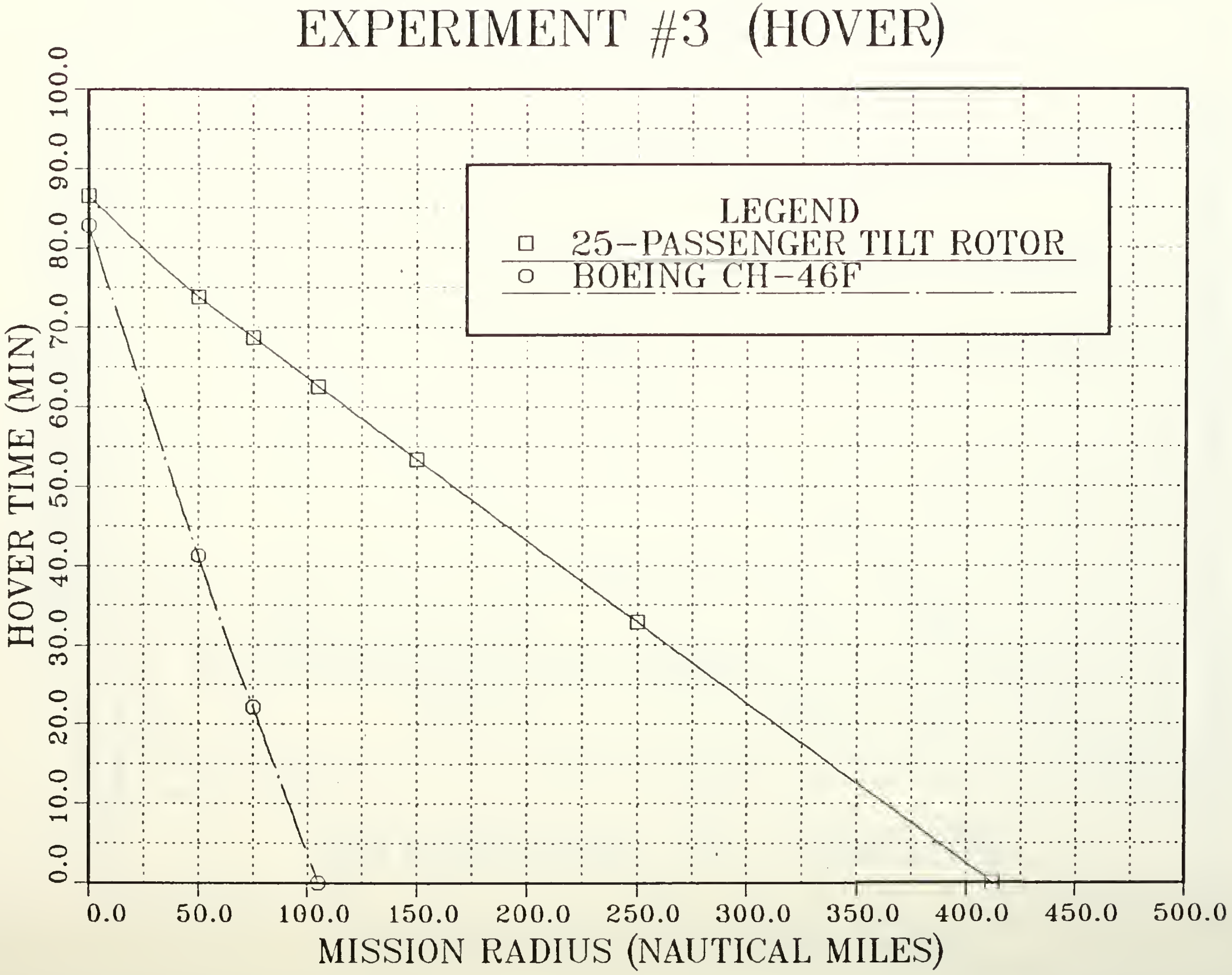

Fig 6. Hover Time vs. Mission Radius

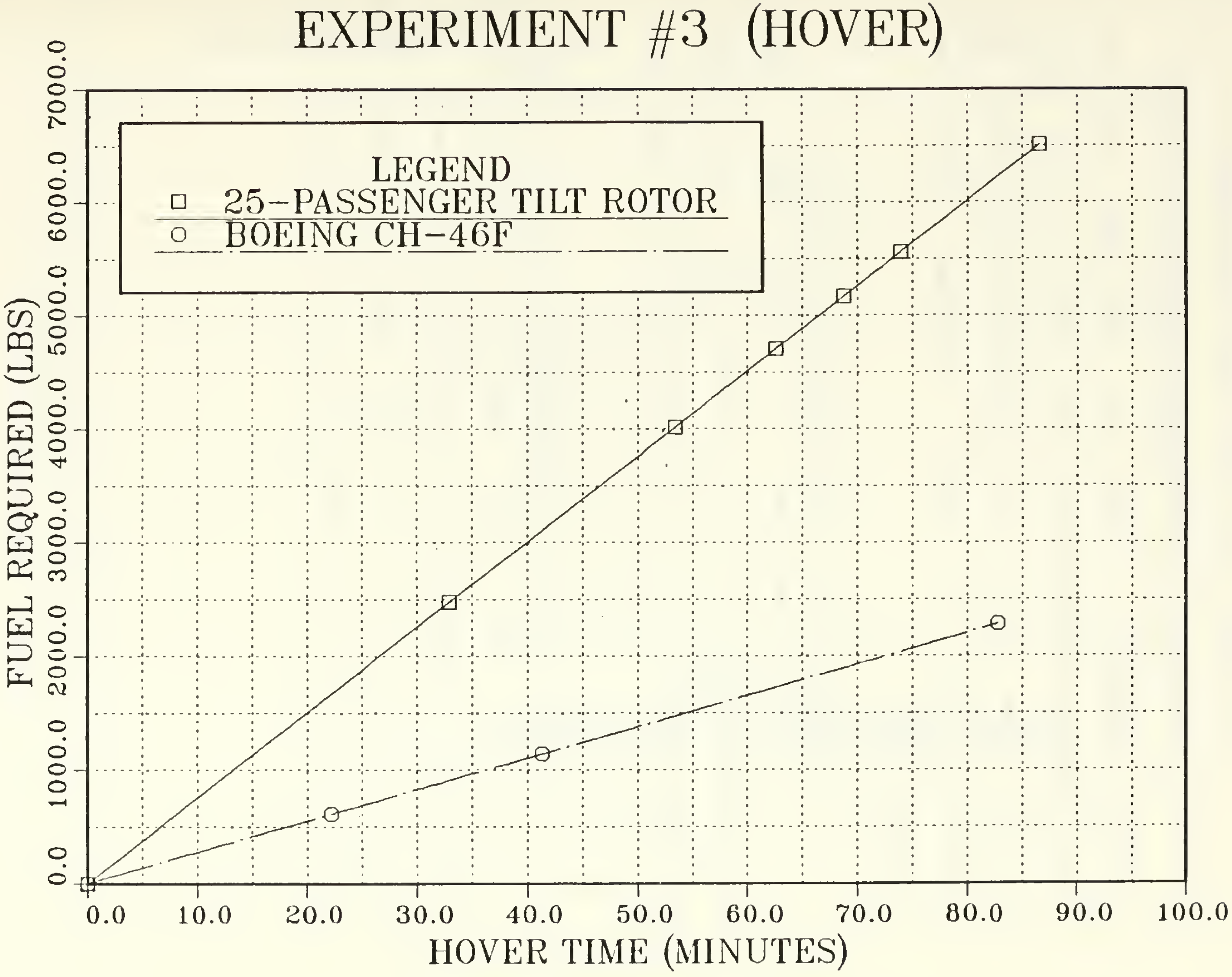

Fig 7. Fuel Required vs. Hover Time

D. EXPERIMENT #4

1. Fig 8, Pg 95 - Fuel Required vs Range

This graph shows that one 44-passenger tilt rotor can do the job of two 25-passenger helicopters (operating at 88% seating capacity) using less fuel even when travelling to sites that are separated by distances of up to 250 NM. It is evident that even if the helicopters were operating at full capacity, the tilt rotor's advantage would not decrease substantially.

2. Fig 9, Pg 96 - Time Required vs Range

The 44-passenger tilt rotor, when travelling to locations separated by distances of up to nearly 300 NM, performs better than two CH-46F helicopters that are flying a 103 NM radius to the same locations.

3. Fig 10, Pg 97 - Passenger-Mile per Lb of Fuel vs Rng

This final graph shows that using one 44-passenger tilt rotor travelling to two landing sites separated by 150 NM or more is more efficient than using two tandem rotor CH-46F helicopters to cover the same two landing sites.

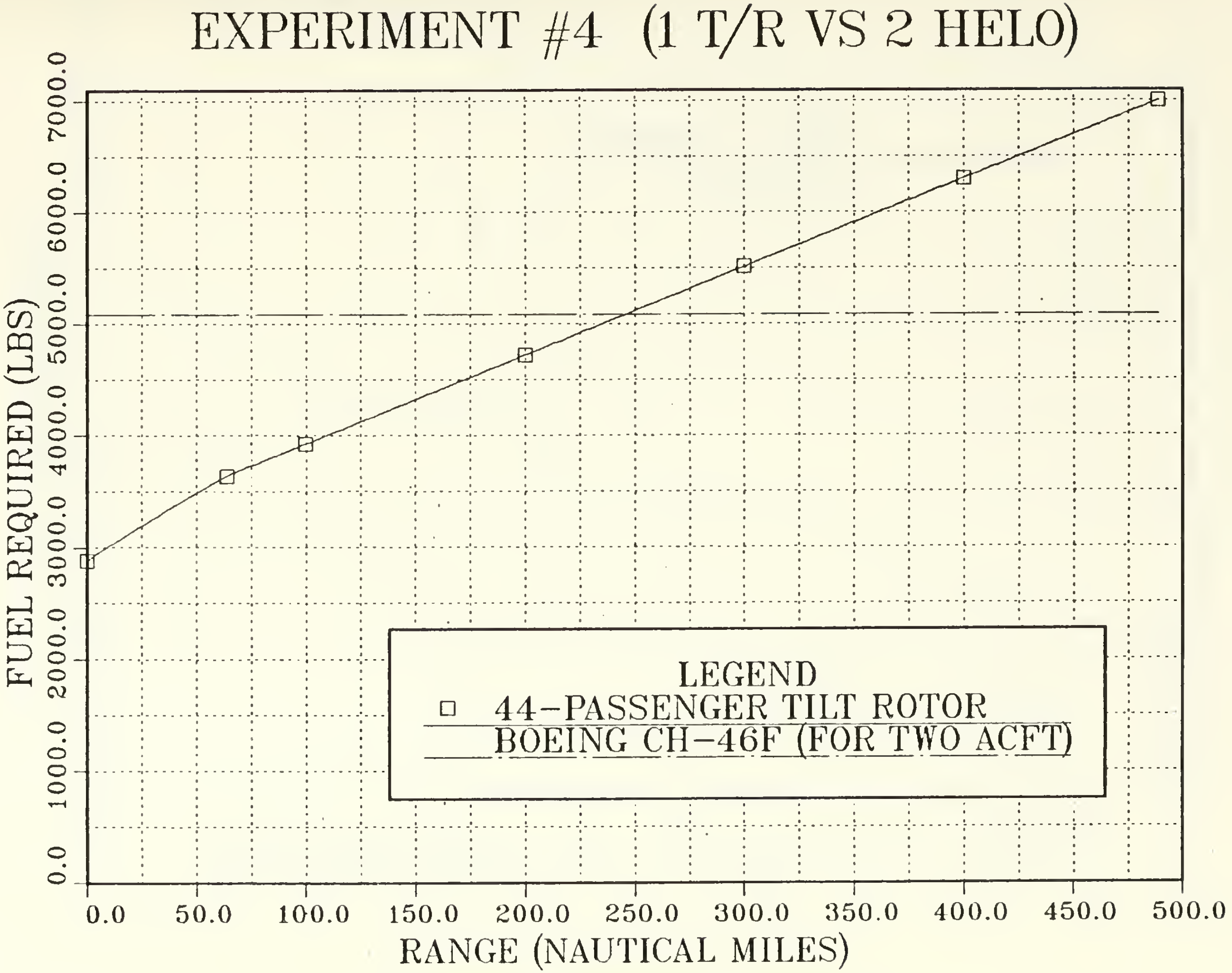

Fig 8. Fuel Required vs. Range

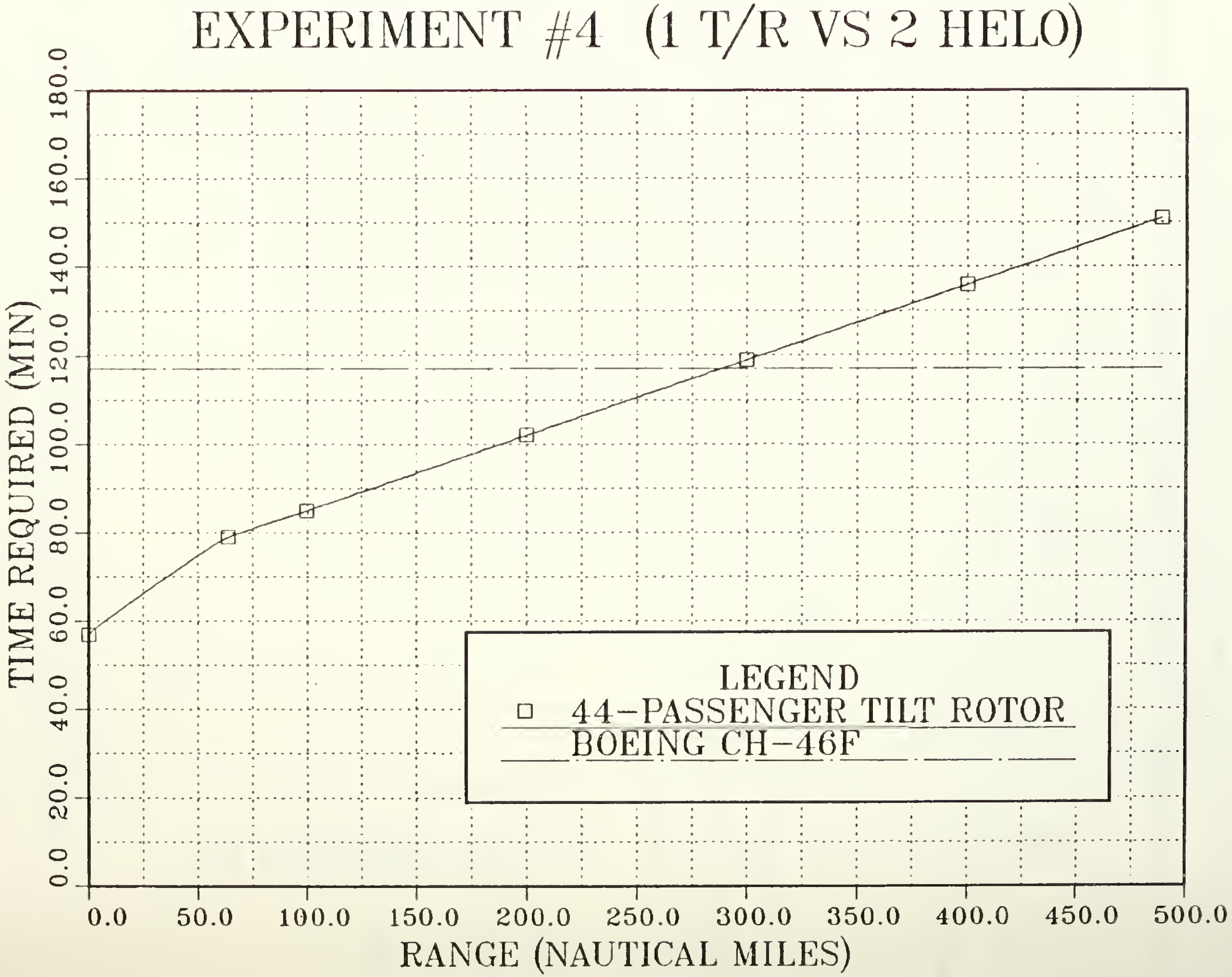

Fig 9. Time Required vs. Range

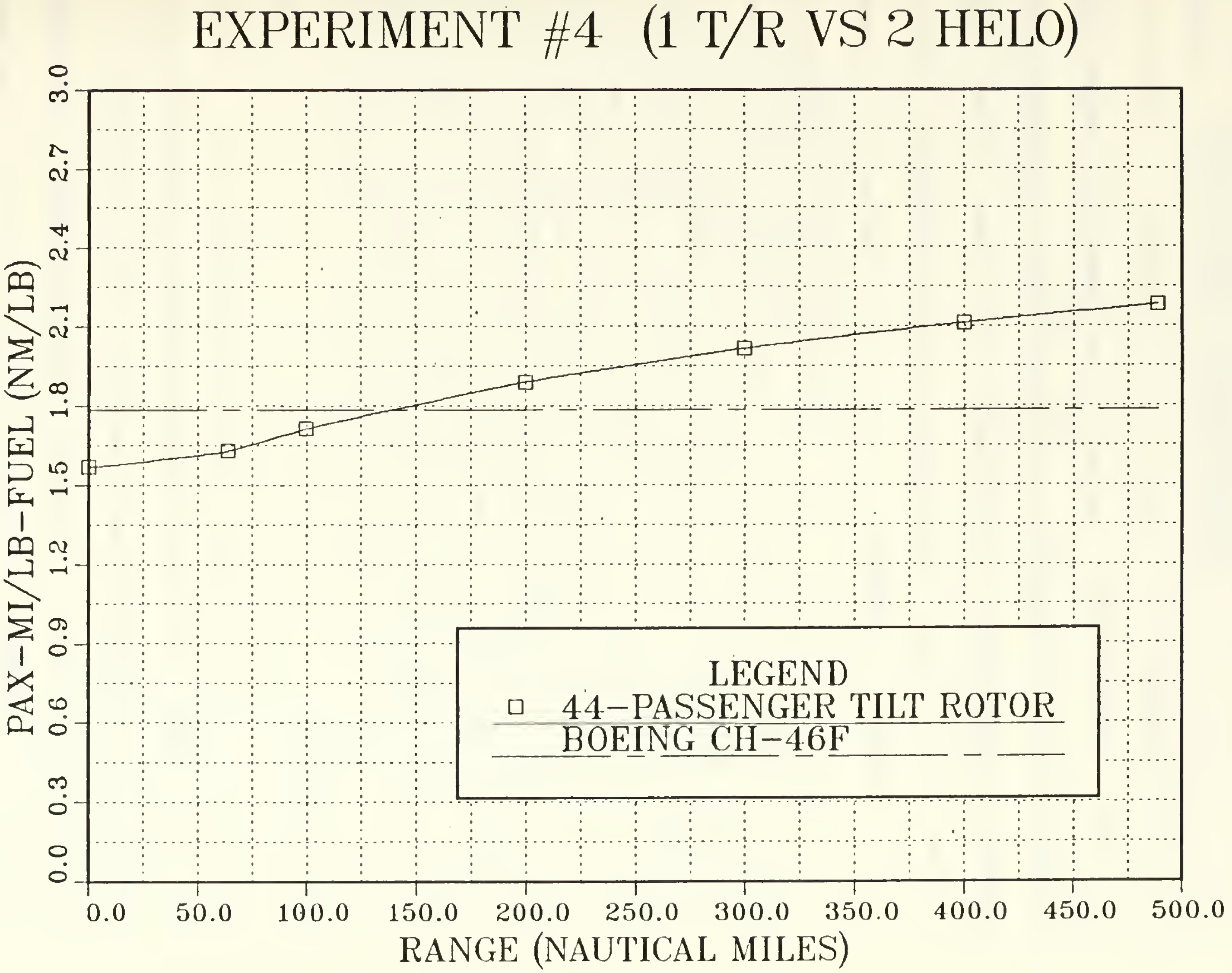

Fig 10. Pax-Mi/Lb-Fuel vs. Range

VII. DISCUSSION AND CONCLUSIONS

A. EXPERIMENTS

The experimental results substantiate that the V-22, designated to replace the CH-46F among other aircraft, will offer significant improvements in speed, loiter endurance, hover endurance, performance, and efficiency. The results lend further credence to the manufacturer's claims that tilt rotor aircraft can transport more passengers/payload over longer distances in less time than conventional helicopters while retaining the important advantage of vertical takeoff and landing. It is acknowledged that the tilt rotor can readily perform transport missions using less fuel than helicopters but if a large percentage of hovering flight is required, conventional rotary wing aircraft are far more efficient from a fuel consumption standpoint. However, they do not have the staying power that the tilt rotor demonstrates.

B. TILT ROTOR ADVANTAGES TO THE MILITARY

The speed and efficiency of the V-22 will allow greater stand-off ranges for naval assault fleets; permit more rapid buildup of assault forces at objectives while retaining the ability to operate from small ships and/or to maintain an independence from runways.

C. TILT ROTOR ADVANTAGES TO THE CIVILIAN AVIATION COMMUNITY

The high productivity of the tilt rotor will provide much needed relief in air traffic congestion at major airports by providing a vehicle that has twice the speed of conventional helicopters without sacrificing the ability to transport passengers on a city-center to city-center basis. This will, effectively, reduce the requirement to increase the number of available commuter jets and turboprops as transportation demands increase.

D. COMPUTER PROGRAMS

Both VASCOMP II and HESCOMP were found to be relatively straightforward in their application. Each program has an enviable range of versatility and flexibility. The most difficult factor in working with the programs is, without a doubt, obtaining the input data. Without the cooperation of an agency such as NASA Ames Research Center it would be extremely difficult to compile a complete data set for any given aircraft. Aircraft manufacturers are a potential source for data. The aircraft for which it is easiest to obtain data are those produced for the military. As part of the procurement process, manufacturers are required to submit a MIL-STD Form 1374 entitled GROUP WEIGHT STATEMENT which provides detailed weight data as well as dimensional and structural data. This document is generally available for official uses.

Concerning the accuracy of the programs in the faithful representation of the aircraft described by the input data, it is felt that the trends routines built into the program do an adequate job of approximating the vehicle and the flexibility of the program more than adequately allows for adjusting the output to obtain results which match actual flight test data.

APPENDIX

VASCOMP USER´S MANUAL

This User´s Manual was completed in conjunction with thesis research. It was prepared using the guidelines that the manual should:

1. Provide helpful information for those individuals interested in using VASCOMP II at the Naval Postgraduate School (NPS), Monterey, California.
2. Provide information in such a way that a user could run VASCOMP II without relying on material elsewhere in this thesis.
3. Simplify, to a large extent, the material presented in the Boeing VERTOL Company VASCOMP II User´s Manual.
4. Include examples of:
    a. Required Job Control Language (JCL) statements for using VASCOMP II on the IBM 3033 computer at NPS.
    b. Sample data for a V/STOL aircraft.
    c. Sample output for a V/STOL aircraft.

I. INTRODUCTION

A. PURPOSE

This manual was designed to provide the user with a simplified version of the Boeing VERTOL Company's VASCOMP II User's Manual. A copy of the Boeing VERTOL user's manual is catalogued and available at the Dudley Knox Library at NPS. Also included in this manual are examples of:

1. Required Job Control Lanugage (JCL) statements for using VASCOMP II on the IBM 3033 computer at NPS.
2. Sample data for a V/STOL aircraft.
3. Sample output for a V/STOL aircraft.

B. APPLICABILITY

VASCOMP II, the V/STOL Aircraft Sizing and Performance Computer Program, is a viable computer program for predicting size and performance data for V/STOL aircraft. It can be used for any aircraft which employs fixed wing lift during primary cruise flight.

C. PROGRAM OPERATION AT NPS

Due to the large size of VASCOMP II, (in excess of 16,000 lines of FORTRAN code), production runs at NPS should be accomplished using the batch operating system on the IBM 3033 Network referred to as MVS (Multiple Virtual System). Chapter II of this manual provides an explanation and an example of the Job Control Language statements required for running VASCOMP II on the batch system. Chapter II also describes the procedure for running the program on VM/CMS.

D. PROGRAM DATA

Production runs of VASCOMP II require a significant quantity of data. Chapter III provides information on the format of the data file and a list/description of the data locations.

E. V/STOL AIRCRAFT EXAMPLE

Chapter IV consists of output generated by running the program with the data shown in Chapter III.

II. PROGRAM OPERATION AT NPS

A. The VASCOMP II program can be run at NPS by one of two means. The user is highly encouraged to utilize the MVS batch system due to the excessive size of the program. This is primarily for the user′s convenience since, in order to run the program using VM/CMS, the program would have to be filed on an A-disk and would require 37% of the normal eight cylinder allocation for storage alone. Using only eight cylinders, it is not possible to compile the program. If it is necessary to use VM to run the program, the user can request allocation of a B-disk or, as an alternative, it is possible to create a temporary disk of variable size any time the user logs onto VM/CMS. NOTE: Files on a temporary disk are truly temporary. FILES ARE LOST IF THE USER LOGS OFF OR IF THE SYSTEM GOES DOWN UNEXPECTANTLY. A user can create a temporary disk using the following steps:

1. Create an EXEC File

In CMS type: `XEDIT TDISK EXEC`

2. Temporary Disk EXEC File Commands

Type the following lines into the file:

```
& TRACE
CP DEFINE T3350 200 CYL 24
& STACK YES
& STACK TDISK
FORMAT 200 C
ACCESS 191 B
```

3. Create a Second EXEC File

In CMS type: XEDIT MODES EXEC

4. Modes EXEC File Commands

Type the following lines into the file:

```
ACCESS 200 A
```

5. Activate the EXEC Files

In CMS type: TDISK. Wait for the "R;" response then type: MODES.

6. File Alignment

The user now has a 24 cylinder "temporary" A-disk and an 8 cylinder B-disk. All default files will go to the temporary A-disk. Move files for permanent storage on the 191 disk by typing the following command next to the file in FLIST: COPY / = = B

B. PROGRAM OPERATION USING VM/CMS

Use VS FORTRAN if the program is to be run on VM.

C. PROGRAM OPERATION USING VMS BATCH

The preferred mode of operation is to the MVS batch. To run VASCOMP II on MVS batch at the Naval Postgraduate School, the user must access the "AERO DISK" and locate the file entitled: VASCOMP FORTRAN A1. Browse the file for further information on program operation.

D. JOB CONTROL LANGUAGE (JCL) STATEMENTS FOR DATA FILE

When the user has compile the necessary data to run the program, create a FORTRAN file by following the steps below.

1. Create the File

In CMS type: XEDIT (filename) FORTRAN

2. Job, Main, Procedure, and DD Statements

Place the following Job Control Language (JCL) statements at the top of the file:

```
//jobname JOB (nnnn,9999),'ident',CLASS=C
//*MAIN ORG=NPGVM1.nnnnP
//GO   EXEC  PGM=VASII
//STEPLIB   DD   DSN=MSS.Fxxxx.VASCOMP,DISP=SHR
//          DD   DSN=SYS1.pp.VFORTLIB,DISP=SHR
//FT06F001 DD   SYSOUT=A
//FT07F001 DD   SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,
//              BLKSIZE=1300)
//FT05F001 DD   *
```

where,

- The jobname may contain eight alphanumeric characters. The first character must be alphabetic.
- nnnn is the user number assigned by the computer center.
- ident may contain twenty characters (including blanks).
- Correct spelling and spacing on the JOB and MAIN statement (first and second line, respectively) is critical.
- To send the program output to the remote printer in Halligan Hall, modify the MAIN statement by replacing NPGVM1.nnnnP with NPGVM1.HAL

3. Program Data

The data for the program is placed immediately after the last JCL statement (see example below).

4. Delimiter and Null Statements

Place the following JCL statements immediately after the last line of the program data:

```
/*
//
```

The delimiter (/*) statement is an end of file statement for marking the end of a data set. The null (//) statement is used to mark the end of the job. Without the null statement the user may find that the program will not run with any degree of consistency.

B. DATA FILE EXAMPLE

A complete data file, including proper JCL statements, for a program calibration run using an 8-passenger tilt rotor aircraft is included in Chapter III of this manual. The following is an example of the proper placement of the JCL statements.

```
//VASWAL01 JOB (1053,9999),'TOM WALSH SMC 2986',CLASS=C
//*MAIN ORG=NPGVM1.1053P
//GO  EXEC  PGM=VASII
//STEPLIB  DD  DSN=MSS.Fxxxx.VASCOMP,DISP=SHR
//         DD  DSN=SYS1.PP.VFORTLIB,DISP=SHR
//FT06F001 DD  SYSOUT=A
//FT07F001 DD  SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,
//             BLKSIZE=1300)
//FT05F001 DD  *
    .
    .
 (data)
    .
    .
/*
//
```

III. DATA LOCATIONS AND DESCRIPTIONS

A. INFORMATION SOURCE ACKNOWLEDGEMENT

It should be noted that a significant portion of the information in this chapter is either paraphrased or taken directly from the Boeing VERTOL Company VASCOMP II Users's Manual. In particular, most of the variable descriptive information is taken from Chapter 5 of the Boeing Manual.

B. ORGANIZATION OF DATA

For efficiency and program logic, each data value is identified by a four-digit integer. For convenience, the data is read in using rows of up to five (5) data values. The format of the FORTRAN "READ" statement is:

```
FORMAT(I4,1x,I1,5(E14.7))
```

When preparing the data file, spacing must match the above format precisely. Failure to accomplish this will result in erroneous data values. The correct sequencing of values for any given line of data is:

COLUMNS	VARIABLE TYPE	DATA DESCRIPTION
01 - 04	INTEGER	First value identification
5	N/A	Blank
6	INTEGER	Number of values in row
7	N/A	Blank
08 - 21	REAL	Value identified in COL 1 - 4
22 - 35	REAL	Value in COL 1 - 4 plus one
36 - 49	REAL	Value in COL 1 - 4 plus two
50 - 63	REAL	Value in COL 1 - 4 plus three
64 - 77	REAL	Value in COL 1 - 4 plus four
77 - 80	N/A	Blank

```
1234567890123456789012345678901234567890123456789012345678901
```

EXAMPLE:

```
0227 4 0.123         72.92         3.0         0.25
```

In this example, the data line contains four data values (the numbers at the top of the page are for the convenience of the manual user to verify the column locations of the data). The first data value, number 0227, is 0.123. The second data value, number 0228, is 72.92. The third value, number 0229, is 3.0. The fourth data value, number 0230, is 0.25.

C. COMMENT, END-OF-CASE-STUDY, AND EXIT LINES

1. Two types of comment lines can be included in the program data.

a. The first type of comment is one which the user desires to have repeated at the top of each page of program output. To accomplish this, place a "7" in column 1 thru 8 on the first line immediately following the JCL statements, On the next line, columns 1 thru 6 must be left blank. Columns 7 thru 80 are then used for any comment (such as type of aircraft being studied, etc.) to be repeated at the top of each and every page of program output.

b. The second type of comment is one which the user desires for separating groups of data. This type of comment card is optional. It is accomplished in the same manner as the first type (by placing a "7" in columns 1 thru 8, etc.) but the comment information will be printed in the output only once. Examples of both types of comment lines are included in the sample data file at the end of this chapter.

c. If the user desires to analyze more than one type of aircraft using only one data file, the data groups can be separated by placing an "8" in columns 1 thru 8. A "7" card and a repeating comment line should immediately follow the "8" card.

d. To properly exit the program, the last data line must contain a "9" in columns 1 thru 8.

D. DATA CATEGORIES

The Boeing VERTOL Company VASCOMP II User´s Manual includes a total of twenty-four different data input sheets. Data can be loosely grouped into six categories:

1. Aircraft General Information
2. Aircraft Dimensional Information
3. Mission Profile Information
4. Engine Cycle Information
5. Propeller Data
6. Supplementary Information

The following paragraphs describe the purpose of each data location

E. AIRCRAFT GENERAL INFORMATION

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0001	Option Indicator (OPTIND) 0 = Program calculates aircraft gross weight, dimensions, and power required. 1 = Program calculates aircraft gross weight, dimensions, and power required to complete a user specified mission flight profile.

2 = Input gross weight and mission profile. Aircraft size remains fixed and program calculates time history performance data and fuel required to complete the mission.

3 = Input operating-weight-empty and mission profile. Aircraft size remains fixed and program calculates takeoff gross weight and fuel required to complete the mission.

For a combination of options 1 and 2, input data to describe the aircraft and mission flight profile at the top of the data file. This data should then be immediately followed by the additional missions for off-design-point performance calculations.

0002 Print Indicator (TNIRPK)

0 = Mission performance data output for the following flight segments will consist of:

All - time, range, fuel used, aircraft weight, press. alt., true airspeed, eng. turbine temp., eng. code specifying eng. performance, and the primary eng. thrust or horsepower fraction (PETF or PEHF).

Takeoff, Hover, and Landing - Thrust to weight ratio, propeller power coeff., propeller thrust coeff., prop tip speed.

Taxi/Takeoff, Hover/Landing - Lift eng. thrust fraction (LETF).

Climb/Cruise/Descent/Loiter - Mach no., equivalent airspeed.

Climb, Cruise, and Descent - Mach number for drag divergence.

Climb and Descent - Flight path angle, and fuselage attitude angle.

Climb - Rate of climb.

Cruise - Specific range.

Descent - Rate of sink.

Loiter - Time rate of fuel consumption.

Takeoff, Hover, Landing, Cruise, and Loiter - Propeller efficiency.

1 = All data output for TNIRPK = 0 is printed. The following information is also printed:

Climb/Cruise/Descent/Loiter - Fuel flow rate, lift, drag, horsepower, thrust, lift coeff., drag coeff., propeller power coefficient, prop advance ratio, propeller thrust coefficient, propeller tip speed, and propeller efficiency.

2 = Delete mission performance data output.

0003 Drag Indicator (DRGIND)

0 = Program calculates drag rise due to compressibility effects.

1 = If drag rise characteristics of the acft are known, a 3-D table of compressibility drag coeff. can be input as a function of Mach number and lift coefficients.

2 = Used for supercritical drag divergence.

0004 Oswald's Efficiency Factor Indicator (OSWIND)

0 = The user inputs a fixed value for Oswald's (spanwise loading) efficiency factor.

1 = Program calculates Oswald's efficiency factor as a function of wing aspect ratio.

0005 Propeller Dimension Indicator (PDMIND)

1 = Input dia. and activity factor per blade.

2 = Input disc loading and activity factor per blade.

3 = Input diameter and thrust coefficient to solidity ratio.

4 = Input propeller disc loading and thrust coefficient to solidity ratio.

0006 Fuselage Dimension Indicator (FDMIND)

0 = Input fuselage length and wetted area.

1 = Input cabin length (constant diameter), nose and tail fineness ratios. Program calculates acft length and wetted area.

2 = Input desired capacity, seat width and pitch, number and width of aisles, number of seats abreast for tourist and first class, galley and lavatory size. Program calculates fuselage size.

0007 Wing Dimension Indicator (WDMIND)

0 = Input wing loading and aspect ratio

1 = Input chord to diameter ratio and disc loading. The size trends subroutine then calculates the wing loading.

2 = Input wing loading and disc loading. The size trends subroutine then calculates the chord to diameter ratio and aspect ratio.

3 = X-Wing configuration

********* DO NOT SET WDMIND = 1 or 2 IF ENGIND = 1 *********

0008 Horizontal Tail Indicator (HTIND)

0 = Program computes H-tail volume coefficient

1 = Input horiz. tail volume coeff. and moment arm. Horiz. tail sfc is then calculated by the size trends subroutine.

2 = Input the horizontal tail area as a fixed size surface.

0009 Vertical Tail Indicator (VTIND)

0 = Program computes vert. tail volume coeff.

1 = Input vert. tail volume coeff. and moment arm. The size trends subroutine then calculates the vertical tail surface area.

2 = Input the vertical tail area as a fixed size surface.

0010 Engine Size Indicator (FIXIND)

0 = Input level of maximum power or thrust. Engine size is fixed.

1 = The engine size is "rubberized" and the engine sizing subroutine calculates the level of maximum power or thrust.

0011 Engine Indicator (ENGIND)

0 = Turboshaft engine cycle.

1 = Turbofan or turbojet engine cycle.

2 = Turbofan engine cycle. Program simulates operation of a convertible engine cycle.

0012 Engine Sizing Indicator (ESZIND)

0 = Engines sized for takeoff conditions only.

1 = Engines sized for takeoff or cruise conditions whichever requires more power.

(No input if LFTIND = 0 or 1)

0013 Lift Engine Indicator (LFTIND)

0 = No separate lift propulsion engine

1 = Propulsion sys. includes a primary engine cycle (cruise) and a lift engine cycle.

0014 Gross Weight Initial Condition (WG00)

[LBS]

0015 Pressure Altitude Initial Condition (H00)

[FEET]; (normally zero except for partial mission analysis).

0016 Range Initial Condition (R00)

[NAUTICAL MILES]; (normally zero except for partial mission analysis).

0017 Time Initial Condition (ST00)

[HOURS]; (normally zero).

0018 Optimum Altitude Indicator (HOPTIN)

0 = Input max alt. for each cruise segment.

1 = Input max alt. Program calculates optimum cruise altitude for segments preceded by a climb or transfer altitude.

0019 Flight Speed Limit Indicator (VLMIND)

0 = No constraints on equivalent airspeed

1 = Max of 250 knots for flight altitudes at or below 10,000 feet as per FAA reqs.

0020 Maximum Operating Mach Number (EMMO)

0021 Maximum Operating Equivalent Airspeed (VMO)

0022 Design Dive Speed (VDIV)

0023 Maneuver Load Factor (EMLF)

[G´S]; As prescribed by Fed Avn Req 31.

0024 Fuel Req´d Multiplicative Reserve Factor (CK1)

Any fraction greater than 1.0 represents the percent of reserve fuel (e.g. 1.1 represents a 10% fuel reserve).

0025 Reserve Fuel Factor (DELWF)

0026 Fuel Flow Multiplicative Drag Factor (CKFF)

0027 thru 0076 Mission Profile Information (SGTIND)

0 = End of mission
1 = Taxi
2 = Takeoff, hover, and landing
3 = Climb
4 = Cruise
5 = Descent
6 = Loiter
7 = Change of fuel weight
8 = Change of payload weight
9 = Transfer altitude
10 = X-Y plotter output
11 = General performance
100 = End of case

Mission profiles are programmed using combinations of the following elements:

1. Segment - A unique portion of the mission such as cruise or climb. A segment starts with a set of initial conditions and ends when a terminal condition has been satisfied.

2. Hop - A set of segments ending at some logical terminal location (such as ground level at the desired range). Thus, a hop might consist of flying from point "A" to point "B" by means of combining the following segments: taxi, takeoff, climb, cruise, descent, landing, and taxi.

3. Leg - A set of hops ending in a refueling of the aircraft.

4. Mission - A set of legs (or hops or segments) which satisfy specific operational requirements. In this program, the mission is the basic element for which the aircraft is sized.

5. Case - A consecutive series of missions for the same aircraft. This program permits the user to analyze a case which consists of a mission for which an aircraft is sized, followed by a different mission which the now sized aircraft performs, followed by yet additional missions.

An array of segment indicators is input to specify the mission being studied. A typical array might be:

```
SGTIND =

1,2,3,4,5,2,1,1,2,3,4,3,4,5,2,7,2,3,4,5,4,5,6,2,1,0,
|     ^      |                ^|                   |
|     |      |                ||                   |
|   SEGMENT  |       REFUELING|                   |
|            |                 |                   |
|<--HOP #1-->|<----HOP  #2---->|<-----HOP  #3----->|
|                              |                   |
|<-----------LEG #1----------->|<-----LEG  #2----->|
|                                                  |
|<-------------------MISSION #1------------------->|
```

0077
THRU NOT USED
0093

0094	Wing Location for 3-View Drawing (SPACE1(18)) 0 = Low 1 = High
0095	Location of Engine on Fuselage (SPACE1(19)) Expressed as fraction of length.
0096	Horiz. Tail 1/4 Chord Sweep (SPACE1(20))
0097	Vert. Tail 1/4 Chord Sweep (SPACE1(21))
0098	Aircraft 3-Views Plot Indicator (SPACE1(22)) Greater than 0.0 generates 3-view plot
0099	NOT USED
0100	1.0 = NPS THESIS2 format; 0.0 = 133 character format

F. AIRCRAFT DIMENSIONAL INFORMATION

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0101	Wing Aspect Ratio (DAM2) (No input when WDMIND = 1,2)
0102	Mean Wing Chord to Prop. Diameter Ratio (DAM3) (No input when WDMIND = 0,2)
0103	Wing Incidence Angle (EYEW) [DEG]; With respect to the fuselage.
0104	Wing Root Thickness to Chord Ratio (TCR)
0105	Wing Tip Thickness Chord Ratio (TCT)
0106	Wing Loading at Design Gross Weight (DAM4) [LBS/SQ FT]; (No input when WDMIND = 1).
0107	Quarter Chord Mean Sweep Angle (DLMCH) [DEG]; (No input if DRGIND=1 & OPTIND=2).

0108 Taper Ratio of Wing (SLM)

Tip chord/root chord

0109 Horizontal Tail Aspect Ratio (ARHT)

0110 Horiz. Tail Position on Vertical Tail (SAH)

Fraction of vert. tail span. 1.0 = "T" tail, 0.0 = horiz. tail on or below the vert. tail root chord.

0111 Horizontal Tail Moment Arm (ELTH)

0112 Horiz. Tail Mean Thickness/Chord Ratio (TLCT)

0113 Horizontal Tail Volume Coefficient (VBARH)

(No input when HTIND = 2)

0114 Horizontal Tail Taper Ratio (SLMH)

0115 Horizontal Tail Planform Area (AAW11)

[SQUARE FEET]; (No input when HTIND = 1)

0116 Prop Blade Attachment Distance (SR)

Measured from centerline of hub as a fraction of the prop radius. (No input when ENGIND = 1).

0117 Distance Between Inboard Prop Tips (YCL)

[FEET]; Measured from the inboard prop tip on one side of the fuselage to the inboard prop tip on the opposite side of the fuselage. (No input when WDMIND = 0).

0118 Prop-Over-Prop Overlap (ZETA1)

Measured as a fraction of the prop radius. (No input when WDMIND = 0).

0119 Prop-Over-Wing-Tip Overlap (ZETA2)

Measured as a fraction of the prop radius. (No input when WDMIND = 0).

0120 Increment in Wetted Area (DLSWSW)

Utilized for protrusions such as landing gear, etc. Ratio of incremental wetted area of airplane to wing planform area.

0121 Fuselage Height (HF)

[FEET]; (No input when FDMIND = 0,2).

0122 Fuselage Length (DAM5)

[FEET]; (No input when FDMIND = 1,2).

0123 Nose Section Fineness Ratio (ELPD)

(No input when FDMIND = 0,2)

0124 Tail Section Fineness Ratio (ELTD)

(No input when FDMIND = 0,2)

0125 Cabin Section Length (ELC)

[FEET]; Length of constant dia. fuselage (No input when FDMIND = 0,2).

0126 Length of Ramp Well (ELRW)

[FEET]; May also represent length of strengthened fuselage portion such as that for rear engine attachment. Used in the calculation of fuselage weight penalty.

0127 Fuselage Wetted Area (DAM6)

[SQ FT]; (No input when FDMIND = 1,2)

0128 Fuselage Width (SWF)

[FEET]

0129 Vertical Tail Aspect Ratio (ARVT)

0130 Vertical Tail Moment Arm (ELTV)

[FEET]

0131 Vert. Tail Mean Thickness Chord Ratio (TCVT)

0132 Vert. Tail Volume Coefficient (VBARV)

(No input when VTIND = 2)

0133 Taper Ratio of Vertical Tail (SLMV)

0134 Area of Vertical Tail (AAW12)

(No input when VTIND = 1)

0135 Position of Main Landing Gear (YMG)

Measured outboard from the side of the body as a fraction of wing semi-span.

0136 Mean Position of Primary Engines (YP)

Measured outboard from airplane centerline as a fraction of wing semi-span.

0137 Mean Position of Lift Engines (YL)

Measured outboard from aircraft centerline as a fraction of wing semi-span (No input when LFTIND = 0).

0138 Lift Engine Cluster Gap Factor (EPSLON)

Set by engine type, engine size, and by the no. of engines which may be clustered together (No input when LFTIND = 0).

0139 Primary Eng. Nacelle Dimen. Factor (AZETA1)

0140 Primary Eng. Nacelle Dimen. Factor (AZETA2)

0141 Primary Eng. Nacelle Dimen. Factor (AZETA3)

0142 Rotor t/c Ratio at 0.25R (SKIP(1))

0143
THRU NOT USED
0150

G. PASSENGER DATA REQUIRED FOR FUSELAGE SIZING (FDMIND = 2)

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0151	Galley Indicator (DNI1GN) 0 = galley area calculated by program 1 = galley area input by user
0152	Total Area of the Galley(s) (AGLLEY) [SQUARE FEET]; (No input if DNI1GN = 0)
0153	First Class Section Passenger Capacity (ANPX1)
0154	No. of Seats Abreast in First Class (ANAB1)
0155	No. of Aisles in First Class (ANISL1)
0156	Width of Seats in First Class (WSEAT1) [INCHES]; A typical value is 27 inches.
0157	Seat Pitch in First Class (PSEAT1) [INCHES]; A typical value is 38 inches.
0158	Aisle Width in First Class (WAISL1) [INCHES]; A typical value is 20 inches.
0159	Lavatory Indicator (DNIVAL) 0 = Number of lavatories calculated by program 1 = Number of lavatories input by user
0160	Number of lavatories (ANLAVS) (No input when DNIVAL = 0).
0161	Tourist Section Passenger Capacity (ANPXT)
0162	No. of Seats Abreast in Tourist (ANABT)
0163	No. of Aisles in Tourist (ANISLT)
0164	Width of Seats in Tourist (WSEATT) [INCHES]; A typical value is 20 inches.

0165 Seat Pitch in Tourist (PSEATT)

[INCHES]; A typical value is 34 inches.

0166 Aisle Width in Tourist (WAISLT)

[INCHES]; A typical value is 16 inches.

0167 Number in Flight Deck Crew (SPACE2(1))

0168 Number of Flight Attendants (SPACE2(2))

0169 THRU 0199 NOT USED

H. AIRCRAFT PROPULSION INFORMATION REQUIRED WHEN ENGIND = 0 (TURBOSHAFT ENGINES)

LOCATION DATA DESCRIPTION (FORTRAN NAME)

0201 Primary Engine Cycle Number (CYCPRP)

TABLE 1

PRIMARY CRUISE ENGINES	ENGINE CYCLE NUMBER	MAX. TURBINE INLET TEMP. (DEGREES R)	COMPRESSOR DESIGN PRESS RATIO	FAN BYPASS RATIO
TURBOSHAFT ENGINE CYCLES	1	2600	13	
	2	2600	16	
	3	2900	13	
	4	2900	16	
	5	2900	19	
	6	3200	13	
	7	3200	16	
	8	3200	19	
	9	3200	22	

0202 Primary Engine Max. Static Horsepower (DAM7)

Total for all engines at stnd. sea level conditions (No input when FIXIND = 1).

0203 NOT USED

0204 Number of Primary Engines (ENP)

0205 NOT USED

0206 Transmission Efficiency (ETAT)

0257 Transmission Indicator (XMSND)

0 = Trans. sized at fraction of installed power (see LOC 0258).

1 = Trans. sized at fraction of installed power (see LOC 0258) or at cruise power required, whichever is more critical.

(No input when ENGIND = 1)

0258 Fraction of Power for Trans. Sizing (XMSMRT)

Ratio of trans. SHP to prim. eng. max static HP (No input when ENGIND = 1).

0259 Accessory Horsepower (DSHPAC)

0223 Number of Rotors or Propellers (ENR)

0224 Propeller Tip Speed (VT)

[FT/SEC]

0225 Disc Loading {Fan Loading if ETAIND = 3} (WGA)

[LBS/SQ FT]; Req´d if OPTIND = 2 or 3 (No input if OPTIND = 1 AND PDMIND = 1 or 3).

0226 Propeller Diameter (DI)

[FT]; NOTE: If ETAIND=3, see note in Ref. 3, pg. 5-7. (No input when PDMIND=2 or 4)

***** LOCATIONS 0207 - 0212 MUST BE INPUT IF FIXIND = 0 *****

0207 Takeoff Altitude (HES)

[FEET]; Typically set equal to zero.

0208 Thrust-to-Weight Ratio (SENE)

0209 Ambient Temp. Increment for Takeoff (TINY)

[DEG FARENHEIT]; Ambient temp. increment for engine sizing at takeoff conditions (For standard atmosphere, TINY = 0.0).

0210 Power Turbine Speed Ratio for Takeoff (AN2TO)

Ratio of operating power turbine speed to max power turbine speed (No input when N2IND = 0 or 1). Required when sizing primary engines for takeoff (see note in Ref. 3, page 5-41).

0211 Number of Inoperative Primary Engines (ENPO)

(No input when FIXIND = 0).

0212 Number of Inoperative Lift Engines (ENLO)

(No input when FIXIND = 0).

0260 Fraction of Power (SHPTO)

Ratio of engine SHP to primary engine max static HP (LOC 0202). Required for sizing engines; nominally input as 1.0.

0261 Vertical Rate of Climb for Takeoff (VRCRC)

[FT/MIN]; For engine sizing at takeoff.

0262 Takeoff Vertical Climb Power Constant (CKRC)

Climb power multiplicative constant; Nominally 2.0 for turboshaft engines; Less for high disc loaded aircraft and fans.

**** LOCATIONS 0213 - 0217 MUST BE INPUT IF XMSNIND = 1 ****

0213 Power Indicator (POWESI)

0 = Maximum rated power

1 = Military rated power

2 = Normal rated power

(No input when FIXIND = 0 or ESZIND = 0)

0214 Cruise Altitude (HC)

[FT]; (No input if FIXIND=0 or ESZIND=0).

0215 True Airspeed at Cruise (VC)

[KTS]; (No input if FIXIND=0 or ESZIND=0).

0216 Ambient Temp. Increment at Cruise (ATMIY)

[DEG FAREN.]; (No input when FIXIND = 0 or ESZIND = 0. For stnd. atmos., ATMIY = 0).

0217 Power Turbine Speed Ratio for Cruise (AN2CR)

Ratio of operating power turbine speed to maximum power turbine speed (No input when N2IND = 0 or 1 or FIXIND = 0 or ESZIND = 0). Required if sizing prim. engines for cruise (see note in Ref. 3, page 5-40).

I. PROPELLER DATA REQUIRED WHEN "ENGIND" = 0 (TURBOSHAFT ENGINES)

LOCATION DATA DESCRIPTION (FORTRAN NAME)

0200 Primary Engine Efficiency Indicicator (ETAIND)

0 = Propulsive efficiencies input by user

1 = Propulsive table input by user

2 = Propulsive performance calculated by prog.

3 = Fan table input by user

************* PROPELLER DATA WHEN "ETAIND" = 0 *************

0227 Thrust Coeff./Prop. Solidity Ratio (CTSIG)

Ratio of thrust coefficient to propeller solidity. If acft is in the helo mode: Ct = thrust/[(density)*(area)*(tip speed)] (No input when PDMIND = 1 or 2)

0228 Activity Factor of Propeller (AF)

[PER BLADE]; (No input if PDMIND = 3 or 4)

0229 Number of Blades on Propeller or Rotor (BLDN)

(No input when PDMIND = 3 or 4)

0232 Static Propeller Efficiency (ETAP2)

"Figure of Merit" for calculations during takeoff/hover/landing (when SGTIND = 2).

0233 Climb Propeller Efficiency (ETAP3)

For climb calculations (SGTIND = 3).

0234 Descent Propeller Efficiency (ETAP5)

For descent calculations (SGTIND = 5).

0235 THRU 0244 Mach Number Table (TBEM5)

Mach no. values to be paired with primary engine propulsive efficiencies for use when SGTIND = 4 (cruise) or 6 (loiter).

0245 Number of Mach No./Efficiency Pairs (ETAP4N)

0246 THRU 0255 Propulsive Efficiency Table (TB8AP4)

Primary eng. propulsive efficiency values to be paired with Mach no. values in LOC 0235 thru 0244. Permits rapid evaluation of sensitivity of aircraft performance and size to changes in propeller performance.

************* PROPELLER DATA WHEN "ETAIND" = 1 *************

0227 Thrust Coeff./Prop. Solidity Ratio (CTSIG)

Ratio of thrust coefficient to propeller solidity. If acft is in the helo mode: Ct = thrust/[(density)*(area)*(tip speed)] (No input when PDMIND = 1 or 2).

0228 Activity Factor of Propeller (AF)

[PER BLADE]; (No input if PDMIND = 3 or 4)

0229 Number of Blades on Propeller or Rotor (BLDN)

(No input when PDMIND = 3 or 4)

0234 Descent Propeller Efficiency (ETAP5)

For descent calculations (SGTIND = 5).

0256 Propeller Table Number (CYPROP)

CYPROP values for five general avn props are given in the table below.

TABLE 2

PROPELLER CHARACTERISTIC SUMMARY
ALL PROPELLERS ARE 3-BALDED, CONSTANT SPEED

MANUFACTURER	DESIGNATION [TABLE NO.]	INTEGRATED DESIGN LIFT COEFFICIENT	ACTIVITY FACTOR PER BLADE	APPLIC.
HARTZELL PROPELLERS, INC.	T10282H [10282.3]	0.555	114 (118)	TWIN OTTER SKYVAN
HARTZELL PROPELLERS, INC.	T10173-8 [101738.3]	0.620 (0.700)	104 (107)	BEECH KING AIR 99
HAMILTON STANDARD DIV., UAC	33LF 1033A-0 [1033.3]	0.424	127	HAWK CMDR
HAMILTON STANDARD DIV., UAC	33LF 1027A-0 [1027.3]	0.500	110	
HAMILTON STANDARD DIV., UAC	33LF 1013A-0 [1013.3]	0.483	97	

NOTE: Values in parenthesis are quoted by Hartzell Props, Inc. Values not in parentheses are consistent with the blade geometric data supplied by Hartzell.

1700 User´s Propeller Table Number (PROPCY)

A table of actual prop performance data obtained from test data can be input. Refer to Ref. 3, page 4-63 for a complete description of the table requirements.

1701 Number of Advance Ratio Values (XPXNO)

To be assigned to loc 1702-1721 NOTE: If used, XPXNO must at least equal 3.

1702 THRU 1721 Propeller Advance Ratio Table (XPJ)

Table of propeller advance ratio values to be input by user (minimum of 3 values).

1722 Number of Prop Power Coefficients (CPPNO)

No. of prop pwr coeff. to be input by the user in loc 1723-1742. If used
a table of at leasts used, a value of
at least "3" must be assigned to CPPNO.

1723 THRU 1742 Propeller Power Coefficients (CPPROP)

Table of propeller power coeff. values to be input by user (minimum of 3 values).

1743 THRU 2142 Values of Prop Thrust Coefficients (CTPROP)

Table of propeller thrust coeff. values.

************* PROPELLER DATA WHEN "ETAIND" = 2 *************

0227 Thrust Coeff./Prop. Solidity Ratio (CTSIG)

Ratio of thrust coefficient to propeller solidity. If acft is in the helo mode:
Ct = thrust/[(density)*(area)*(tip speed)]
(No input when PDMIND = 1 or 2)

0228 Activity Factor of Propeller (AF)

[PER BLADE]; (No input if OPTIND = 1 and PDMIND=3,4; ALWAYS req´d if OPTIND = 2, 3)

0229 Number of Blades on Propeller or Rotor (BLDN)

0230 Prop Integrated Design Lift Coeff. (CLEYE)

0234 Descent Propeller Efficiency (ETAP5)

For descent calculations (SGTIND = 5).

************ PROPELLER DATA WHEN "ETAIND" = 3 ************

0227 Thrust Coeff./Prop. Solidity Ratio (CTSIG)

Ratio of thrust coefficient to propeller solidity. If acft is in the helo mode:
Ct = thrust/[(density)*(area)*(tip speed)]
(No input when PDMIND = 1 or 2)

0228	Activity Factor of Propeller (AF) [PER BLADE]; (No input if PDMIND = 3 or 4)
0229	Number of Blades on Propeller or Rotor (BLDN) (No input when PDMIND = 3 or 4)
0230 THRU 0233	NOT USED
0234	Descent Propeller Efficiency (ETAP5) For descent calculations (SGTIND = 5).
0256	Fan Table Number (CYPROP) User selected no. to identify Fan Table.
0408	Tilting Mechanism Constant (SKTM) Tilt wing or tilt rotor tilt mechanism weight factor. This constant calculates a tilt mechanism weight proportional to the acft gross weight.
0457	Rotor/Prop Weight Adjustment Factor (SKRP) To avoid using the prop weights equations, input this variable value as zero.
1700	User's Fan Table Number (PROPCY) As assigned by user in LOC 0256.
1701	Number of Mach Number Values (XPXNO) To be assigned to locations 1702 - 1721 NOTE: If this table is used, a value of least "3" must be assigned to XPXNO.
1702 THRU 1721	Mach Number Values (XPJ) Table of Mach Number values to be input by the user (minimum of 3 values).
1722	Number of Referred Power Coefficients (CPPNO) No. of referred power coefficients to be input by the user to LOC 1723 - 1742.

NOTE: If this table is used, a value of at least "3" must be assigned to CPPNO.

1723 THRU 1742	Referred Power Coefficient Values (CPPROP) Table of referred power values to be input by the user (minimum of 3 values).
1743 THRU 2142	Referred Thrust Coefficient Values (CTPROP) Table of referred thrust coeff. values.

J. AIRCRAFT PROPULSION INFORMATION REQUIRED WHEN ENGIND = 1 (TURBOJET OR TURBOFAN ENGINES)

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0201	Primary Engine Cycle Number (CYCPRP) To be selected from the TABLE 3 (below).

TABLE 3

PRIMARY CRUISE ENGINES	ENGINE CYCLE NUMBER	MAX. TURBINE INLET TEMP. (DEGREES R)	COMPRESSOR DESIGN PRESS RATIO	FAN BYPASS RATIO
TURBOJET ENGINE CYCLES	10	2600	13	
	11	2600	16	
	12	2900	13	
	13	2900	16	
	14	2900	19	
	15	3200	13	
	16	3200	16	
	17	3200	19	
	18	3200	22	
TURBOFAN ENGINE CYCLES	19,20,21	2600	16	2,4,6
	22,23,24	2600	20	2,4,6
	25,26,27	2900	16	2,4,6
	28,29,30	2900	20	2,4,6
	31,32,33	2900	24	2,4,6
	34,35,36	3200	16	2,4,6
	37,38,39	3200	20	2,4,6
	40,41,42	3200	24	2,4,6
	43,44,45	3200	28	2,4,6

0203 Primary Engine Maximum Static Thrust (DAM8)

Total thrust for all engines at stnd. sea level conditions (No input if FIXIND = 1).

0204 Number of Primary Engines (ENP)

0218 Lift Engine Cycle Number (CYCLFP)

See table below (No input if LFTIND = 0).

TABLE 4

LIFT ENGINES	ENGINE CYCLE NUMBER	MAX. TURBINE INLET TEMP. (DEGREES R)	COMPRESSOR DESIGN PRESS RATIO	FAN BYPASS RATIO
INDEPENDENT LIFT ENGINES	46,47,48	2400	7	2,4,6
	49,50,51	2700	7	2,4,6
	52,53,54	3000	7	2,4,6
GAS COUPLED LIFT FANS	55,56,57	2600	13	8,11,14
	58,59,60	2600	16	8,11,14
	61,62,63	2900	13	8,11,14
	64,65,66	2900	16	8,11,14
	67,68,69	2900	19	8,11,14
	70,71,72	3200	13	8,11,14
	73,74,75	3200	16	8,11,14
	76,77,78	3200	19	8,11,14
	79,80,81	3200	22	8,11,14

0219 Lift Engine Maximum Static Thrust (DAM9)

Total for all eng; stnd. sea level; (No input if FIXIND = 1 or LFTIND = 0).

0220 Number of Lift Engines (ENL)

(No input when LFTIND = 0)

0221 Number of Clusters of Lift Engines (ENC)

(No input when LFTIND = 0)

0231 Lift Engine Efficiency (ETAC)

(No input when LFTIND = 0).

0232 Primary Engine Propulsive Efficiency (ETAP2)

To be used for Takeoff, Hover, and Landing conditions (SGTIND = 2).

0207 Takeoff Altitude (HES)

[FEET]; Required for sizing engines and is typically set equal to zero.

0208 Thrust-to-Weight Ratio (SENE)

0209 Ambient Temp. Increment for Takeoff (TINY)

[DEG FARENHEIT]; Ambient temp. increment for engine sizing at takeoff conditions (For standard atmosphere, TINY = 0.0).

0210 Power Turbine Speed Ratio for Takeoff (AN2TO)

Ratio of operating power turbine speed to maximum power turbine speed (No input when N2IND = 0 or 1 or FIXIND = 0). Required when sizing primary engines for takeoff (see note in Ref. 3 page 5-41).

0211 Number of Inoperative Primary Engines (ENPO)

Required for engine sizing (No input when FIXIND = 0).

0212 Number of Inoperative Lift Engines (ENLO)

Required for engine sizing (No input when FIXIND = 0).

```
*************************************************************
*     LOCATIONS 0213 - 0217 MUST BE INPUT IF LFTIND = 1     *
*************************************************************
```

0213 Power Indicator (POWESI)

0 = Maximum rated power

1 = Military rated power

2 = Normal rated power

(No input when FIXIND = 0 or ESZIND = 0)

0214 Cruise Altitude (HC)

[FEET]; This data is required for sizing the engines (No input when FIXIND = 0 or ESZIND = 0).

0215 True Airspeed at Cruise (VC)

[KNOTS]; This data is required for sizing the engines (No input when FIXIND = 0 or ESZIND = 0).

0216 Ambient Temperature Increment at Cruise (ATMIY)

[DEGREES FARENHEIT]; This data is used for sizing the engines (No input when FIXIND = 0 or ESZIND = 0. For standard atmosphere, ATMIY = 0.0).

0217 Power Turbine Speed Ratio for Cruise (AN2CR)

Ratio of operating power turbine speed to maximum power turbine speed (No input when N2IND = 0 or 1 or when FIXIND = 0 or ESZIND = 0). Required when sizing primary engines for cruise (see note in Ref. 3, page 5-40).

0200 Primary Engine Propulsive Efficiency Indicator (ETAIND)

MUST be input as "3". The user is required to input a fan table (Locations 1700 to 2142). Also, the rotor/propeller weight adjustment factor must be input as zero (Location 0457).

K. AIRCRAFT PROPULSION INFORMATION REQUIRED WHEN ENGIND = 2 (CONVERTIBLE ENGINES)

LOCATION DATA DESCRIPTION (FORTRAN NAME)

0201 Primary Engine Cycle Number (CYCPRP)

To be selected from Table 5 on page 134 below. NOTE: The number entered at this location must match the number entered at location 1301 to avoid an error message.

TABLE 5

PRIMARY CRUISE ENGINES	ENGINE CYCLE NUMBER	MAX. TURBINE INLET TEMP. (DEGREES R)	COMPRESSOR DESIGN PRESS RATIO	FAN BYPASS RATIO
TURBOSHAFT ENGINE CYCLES	1	2600	13	
	2	2600	16	
	3	2900	13	
	4	2900	16	
	5	2900	19	
	6	3200	13	
	7	3200	16	
	8	3200	19	
	9	3200	22	
TURBOJET ENGINE CYCLES	10	2600	13	
	11	2600	16	
	12	2900	13	
	13	2900	16	
	14	2900	19	
	15	3200	13	
	16	3200	16	
	17	3200	19	
	18	3200	22	
TURBOFAN ENGINE CYCLES	19,20,21	2600	16	2,4,6
	22,23,24	2600	20	2,4,6
	25,26,27	2900	16	2,4,6
	28,29,30	2900	20	2,4,6
	31,32,33	2900	24	2,4,6
	34,35,36	3200	16	2,4,6
	37,38,39	3200	20	2,4,6
	40,41,42	3200	24	2,4,6
	43,44,45	3200	28	2,4,6

0203 Primary Engine Maximum Static Thrust (DAM8)

[LBS-FORCE]; Total for all engines at stnd. sea level (No input if FIXIND = 1).

0204 Number of Primary Engines (ENP)

0205 Convertible Engine Conversion Ratio (BETA)

[LBS-FORCE PER HORSEPOWER]

0206 Transmission Efficiency (ETAT)

0257 Transmission Indicator (XMSND)

0 = Trans. sized at fraction of installed power (fraction at LOC 0258).

1 = Trans. sized at fraction of installed power (fraction at location 0258) or at cruise power required, whichever is more critical.

(No input when ENGIND = 1)

0258 Fraction of Power for Trans. Sizing (XMSMRT)

Ratio of transmission shaft horsepower to primary engine maximum static horsepower (location 0202)

(No input when ENGIND = 1)

0259 Accessory Horsepower (DSHPAC)

[HORSEPOWER]

0223 Number of Rotors or Propellers (ENR)

0224 Propeller Tip Speed (VT)

[FEET PER SECOND]

0225 Disc Loading {Fan Loading if ETAIND = 3} (WGA)

[LBS/SQ FT]; This is always required if OPTIND = 2 or 3 (No input when OPTIND = 1 AND PDMIND = 1 or 3).

0226 Propeller Diameter (DI)

[FEET]; If ETAIND = 3, see note in Ref. 1 page 5-7 (No input when PDMIND = 2 or 4).

0227 Thrust Coeff./Prop. Solidity Ratio (CTSIG)

Ratio of thrust coefficient to propeller solidity. If acft is in the helo mode: Ct = thrust/[(density)*(area)*(tip speed)] (No input when PDMIND = 1 or 2)

0228 Activity Factor of Propeller (AF)

[PER BLADE]; (No input if PDMIND = 3 or 4)

0229 Number of Blades on Propeller or Rotor (BLDN)

(No input when PDMIND = 3 or 4)

0232 Static Propeller Efficiency (ETAP2)

"Figure of Merit" for calculations during takeoff, hover, and landing (SGTIND = 2).

```
*******************************************************
*    LOCATIONS 0207 - 0212 MUST BE INPUT IF FIXIND = 0    *
*******************************************************
```

0207 Takeoff Altitude (HES)

[FT]; Typically set equal to zero.

0208 Thrust-to-Weight Ratio (SENE)

0209 Ambient Temp. Increment for Takeoff (TINY)

[DEG FARENHEIT]; Ambient temp. increment for engine sizing at takeoff conditions (For standard atmosphere, TINY = 0.0).

0210 Power Turbine Speed Ratio for Takeoff (AN2TO)

Ratio of operating power turbine speed to maximum power turbine speed (No input when N2IND = 0 or 1 or FIXIND = 0). (see note in Ref. 3, page 5-41).

0211 Number of Inoperative Primary Engines (ENPO)

(No input when FIXIND = 0).

0212 Number of Inoperative Lift Engines (ENLO)

(No input when FIXIND = 0).

0260 Fraction of Power (SHPTO)

Ratio of engine SHP to primary engine max static HP (LOC 0202). Nominally set equal to 1.0.

0261 Vertical Rate of Climb for Takeoff (VRCRC)

[FT/MIN]; Req'd for sizing eng. at takeoff

0262 Takeoff Vertical Climb Power Constant (CKRC)

Climb power multiplicative constant; nominally 2.0 for turboshaft engines; Less for high disc loaded aircraft and fans.

0213 Power Indicator (POWESI)

0 = Maximum rated power

1 = Military rated power

2 = Normal rated power

(No input when FIXIND = 0 or ESZIND = 0)

0214 Cruise Altitude (HC)

[FT]; (No input if FIXIND=0 or ESZIND=0).

0215 True Airspeed at Cruise (VC)

[KTS]; (No input if FIXIND=0 or ESZIND=0).

0216 Ambient Temp. Increment at Cruise (ATMIY)

[DEG FARENHEIT]; (No input if FIXIND = 0 or ESZIND as zero).

0217 Power Turbine Speed Ratio for Cruise (AN2CR)

Ratio of operating power turbine speed to maximum power turbine speed (No input when N2IND = 0 or 1 or FIXIND = 0 or ESZIND = 0). Required when sizing primary engines for cruise (see note in Ref. 3, page 5-40).

L. AIRCRAFT AERODYNAMICS INFORMATION

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0301	Vertical Tail Profile Drag Coefficient (CDVTI) Based on vertical tail planform area and a Reynold's number of 1.0E+07.
0302	Lift Eng. Nacelle Profile Drag Coeff. (CDHTI) Based on total wetted area of nacelle cluster and a Reynold's number of 1.0E+07.
0303	Primary Eng Nacelle Profile Drag Coeff. (CDNI) Based on wetted area of all nacelles and a Reynold's number of 1.0E+07.
0304	Horizontal Tail Profile Drag Coeff. (CDLNI) Based on horizontal tail planform area and a Reynold's number of 1.0E+07 (No input when LFTIND = 0).
0305	Profile Drag Increment (DELCD) Based on wing planform area
0306	Oswald's Efficiency Factor (DAM10) Spanwise efficiency factor (No input when OSWIND = 1).
0307	Equivalent Flat Plate Area Increment (DELFE) [SQ FT]; Based on fuselage parasite drag.
0308	Number of Pairs in Table (TLLN) Number of pairs of values in the table of wing profile drag coeff. (LOC 0335 - 0342) versus lift coeff. (LOC 0317 - 0324).
0309	Number of Mach Numbers (TENN) Number of Mach no. values in LOC 0325-0329 for use in table of compressibility drag as a function of Mach number and lift coefficient (No input when DRGIND = 0).

0310 Number of Lift Coefficients (TCLZN)

Number of lift coefficient values in LOC 0343 - 0349 for use in the table of compressibility drag as a function of Mach no. and lift coeff. (No input if DRGIND=0)

0311 Lift Nacelle Multiplicative Drag Factor (CKLN)

0312 Wing Multiplicative Drag Factor (CKW)

0313 Prim. Nacelle Multiplicative Drag Factor (CKN)

0314 Fuselage Multiplicative Drag Factor (CKF)

0315 Vert. Tail Multiplicative Drag Factor (CKVT)

0316 Horiz. Tail Multiplicative Drag Factor (CKHT)

0317 THRU 0324 Lift Coefficient Values (TBCL1)

For the table of wing profile drag coeff. versus lift coefficients

0325 THRU 0329 Mach Number Values (TBEM)

For the table of compressibility drag as a function of Mach number and lift coeff. (No input when DRGIND = 0).

0330 Mean Reynold's No. per Foot for Misson (RECI)

0331 Two-Dimensional Lift Coefficient Slope (CSALF)

[PER RADIAN]

0332 Zero Lift Angle of Attack (ALPHL)

0333 Nondimensional Position Along the Chord (XCPS)

X/C (No input when DRGIND = 1).

0334 Nondimen. Posn. Along Chord at Max t/c (XCTCM)

(X/C)max t/c; (No input when DRGIND = 1).

0335 THRU 0342 Wing Profile Drag Coefficient Values (TBCDWI)

Based on wing planform area at Reynold's Number of 1.0E+07 for the table of wing profile drag coeff. vs lift coeff.

0343 THRU 0349	Lift Coefficient Values (TBCL2) For the table of compressibility drag as a function of Mach number and lift coeff. (No input when DRGIND = 0).
0350 THRU 0384	Drag Increment (TBCDM) Increase in airplane drag due to Mach number (compressibility effects). Input this table as a function of Mach no. and lift coeff. based on wing planform area.
0385	Supercritical Factor (SPACE4(1)) 0.5 = 50% of technology 1.0 = 100% of technology
0386	Max Lift Coeff. to Compute VMC (SPACE4(2))
0387	CLVRD CL of Vert. Tail & Rudder (SPACE4(3))
0388 THRU 0393	NOT USED

M. ROTOR, PROPELLER, AND GEARBOX WEIGHT

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0394	No. of Stages in Main Rotor Drive (SPACE4(10))
0395	Blade Fold Penalty (SPACE4(11)) Default = 1.0 (no fold)
0396	Hub Weight Coefficient (SPACE4(12))
0397	Hub Material/Development Factor (SPACE4(13))
0398	Blade Weight Coefficient (SPACE4(14))
0399	Rotor Type Factor (SPACE4(15)) 1.0 = Fully articulated 2.2 = Hingeless or teetering 9.1 = X-Wing

N. AIRCRAFT WEIGHT INFORMATION

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0400	Operating Weight Empty (OWE1) [LBS]; (No input when OPTIND = 1 or 2).
0401	Weight of Fixed Equipment (WFE) [LBS]
0402	Weight of Fixed Useful Load (WFUL) [LBS]
0403	Weight of Payload (WPL) [LBS]; (No input when OPTIND = 2).
0404	Cockpit Controls Constant (SKCC)
0405	Fixed-Wing Controls Constant (SKFW)
0406	System and Hydraulics Constant (SKH)
0407	Factor for Stability Augmented System (SKSAS) Also includes mixing units
0408	Tilting Mechanism Constant (SKTM)
0409	Upper Control Mechanisms Constant (SKUC)

```
**************************************************************
*   LOCATIONS 0410 - 0415 ARE NOMINALLY SET EQUAL TO 1.0     *
**************************************************************
```

0410	Cockpit Controls Weight Factor (CK15)
0411	Upper Controls Weight Factor (CK16)
0412	Hydraulics Weight Factor (CK17)
0413	Fixed Wing Controls Weight Factor (CK18)
0414	SAS Weight Factor (CK19)
0415	Tilt Mechanism Weight Factor (CK20)

0416 Number of Temperature Pairs (THN)

Number of atmosphere temperature pairs in locations 0440 - 0449 and 0466 - 0475 (No input if ATMIND is never set equal to 2).

```
*****************************************************************
*   LOCATIONS 0417 - 0419 ARE NOMINALLY SET EQUAL TO 0.0        *
*****************************************************************
```

0417 Flt Controls Group Incremental Weight (DELWFZ)

[LBS]

0418 Propulsion Group Incremental Weight (DELWP)

[LBS]

0419 Structures Group Incremental Weight (DELWST)

[LBS]

0420 Body Group Weight Adjustment Factor (SKP)

0421 Lift Engine Section Weight Factor (SKLES)

(No input when LFTIND = 0)

0422 Alighting Gear Weight (SKLG)

Expressed as a percentage of gross weight.

0423 Main Gear Weight to Gross Weight Ratio (SKMG)

0424 Tail Load Adjustment Factor (SKTL)

0425 Wing Bending Relief Moment Adj. Factor (SKWF)

0426 Wing Type Weight Adjustment Factor (SKWW)

0427 Pitch Radius of Gyration (SKY)

[FT]

0428 Yaw Radius of Gyration (SKZ)

[FT]

0429 Primary Engine Section Weight Factor (SKPES)

****
NO INPUT TO LOCATIONS 0430 - 0432 UNLESS SKPES = 0 (LOC 0429)
****

0430	Engine Nacelle Type Factor (SKMT)
0431	Engine Nacelle Adjustment Factor (SKNAC)
0432	Engine Attachment Point Ratio (SKLMT) Distance between engine center of gravity and closest structural attachment point between nacelle and wing expressed as a ratio to the length of the nacelle.
0433	Wing Weight Multiplicative Weight Factor (CK8)
0434	Horiz. Tail Wt Multiplic. Weight Factor (CK9)
0435	Vert. Tail Wt Multiplic. Weight Factor (CK10)
0436	Fuselage Wt Multiplic. Weight Factor (CK11)
0437	Landing Gear Wt Multiplic. Wt Factor (CK12)
0438	Lift Eng. Section Multiplic. Wt Factor (CK13)
0439	Primary Eng. Sec. Multiplic. Wt Factor (CK14)
0440 THRU 0449	Non-Standard Atmosphere Altitude (TBH) [FT]; Altitudes to be paired with ambient temperature ratios (LOC 0466 - 0475) for the non-standard atmosphere table.
0450	Cabin Differential Pressure Limit (DELP) [PSI]
0451	Weight of Concentrated Load (WC) [LBS]
0452	Concentrated Load Position (YC) Distance of load outboard from aircraft centerline. Expressed as a fraction of the wing semi-span.

0453 Drive System Weight Adjustment Factor (SKDS)

0 = No gearbox weight.

1 = Ham. standard gearbox weight trend.

(No input when ENGIND = 1)

0454 Fuel System Weight Adjustment Factor (SKFS)

0455 Lift Engine Installation Weight Factor (SKLEI)

(No input when LFTIND = 0)

0456 Primary Engine Install. Weight Factor (SKPEI)

0457 Rotor or Prop Weight Adjustment Factor (SKRP)

-1 = Use HESCOMP rotor and drive weight trend. (LOC 0394-0399 rotor coeff., LOC 0453 drive coeff. Also, LOC 0142 if not X-Wing configuration).

0 = No prop wt (Use if ETAIND=3 LOC 0200).

1 = 1970 Ham. standard prop weight factors

2 = 1980 Ham. standard prop weight factors

0458 Drive Sys. Weight Variation Adj. Factor (SKVT)

Adjustment factor for variations in drive system weight due to nonuniformities in hover tipspeed and transmission tipspeed or the maximum power and the transmission design power are not the same. The nominal value is 1.0 when these parameters are similar. The value of SKVT will vary when tip speed and power change as indicated by the following expression:

$$\frac{\text{(Design Tipspeed)}}{\text{(Hover Tipspeed)}} \times \frac{\text{(Maximum Power)}}{\text{(Design Power)}}$$

Airplane category in Ham standard prop and gearbox weight can be used by the input of a negative value of the category {-1, -2, -3, etc.} (No input when ENGIND = 1).

0459	Propeller Group Multiplic. Weight Factor (CK2)
0460	Drive System Multiplic. Weight Factor (CK3)
0461	Lift Engine Multiplic. Weight Factor (CK4)
0462	Primary Engine Multiplic. Weight Factor (CK5)
0463	Lift Eng. Install. Multiplic. Wt Factor (CK6)
0464	Prim. Eng. Install. Multiplic. Wt Factor (CK7)
0465	Fuel System Multiplic. Weight Factor (CK21)
0466 THRU 0475	Ambient Temperature Ratio Values (TBTHE) To be paired with alt. (LOC 0440 - 0449) for the non-standard atmosphere table.

O. ENGINE ACOUSTICAL TREATMENT

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0476	Engine Acoustic Treatment Weight Trend Coefficient (SPACE5(1))
0477	Engine Weight Treatment Factor (SPACE5(2)) (= 0477 * 0478 * WEP)
0478	Multiplicative Factor (SPACE5(3))
0479	NOT USED

P. WEIGHT OF FIXED EQUIPMENT (WFE)/FIXED USEFUL LOAD (WFUL)

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0480	WFE/WFUL Indicator (SPACE5(5)) 0 = WFE and WFUL input in LOC 0401 and 0402. 1 = WFE and WFUL computed by program.
0481	APU Trend Coefficient (SPACE5(6))
0482	Instruments Trend Coefficient (SPACE5(7))
0483	Hydraulics Trend Coefficient (SPACE5(8))

0484 Electrical Trend Coefficient (SPACE5(9))

0485 Avionics Trend Coefficient (SPACE5(10))

0486 First Class Furnishings Coeff. (SPACE5(11))

0487 Tourist Class Furnishings Coeff. (SPACE5(12))

0488 Air Conditioning Coefficient (SPACE5(13))

0489 Anti-Icing Coefficient (SPACE5(14))

0490 Auxiliary Gear Coefficient (SPACE5(15))

0491 Crew Baggage (SPACE5(16))
[LBS/PERSON]

0492 First Class Passenger Service (SPACE5(17))
[LBS/PASSENGER]

0493 Tourist Class Passenger Service (SPACE5(18))
[LBS/PASSENGER]

0494 Water Allocation (SPACE5(19))
[LBS/PERSON]

0495 Emergency Equipment (SPACE5(20))
[LBS]

0496 Crew Catering (SPACE5(21))
[LBS/CREW]

0497 First Class Catering (SPACE5(22))
[LBS/PASSENGER]

0498 Tourist Class Catering (SPACE5(23))
[LBS/PASSENGER]

0499 Unusable Fuel Factor (SPACE5(24))

Q. TAXI INFORMATION {SGTIND = 1}

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0501 THRU 0510	Taxi Segment Atmosphere Indicator (ATMIN1) 0 = Standard atmosphere. 1 = Non-standard atmosphere. User inputs a single point value for the increment in ambient temperature above the standard-day value.
0511 THRU 0520	Incremental Time for Taxi (DELTT) [HRS]
0521 THRU 0530	Ambient Temperature Increment (TIN1) [DEG FARENHEIT]; Used for engine sizing at TAXI conditions (No input when ATMIND = 0 or 2).
0531 THRU 0540	Lift Engine Taxi Segment Factor (SKFL) 0 = Lift engines off during taxi. 1 = Lift engines operating during taxi.
0541 THRU 0550	Power Turbine Speed Ratio (AN2M1) Ratio of operating power turbine speed to maximum power turbine speed {input for both primary and auxiliary independent engines in performance segment 3, TAXI}. See additional information in Ref. 1, page 5-40. (No input when N2IND = 0 or 1).

R. TAKEOFF, HOVER, AND LANDING INFORMATION {SGTIND = 2}

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0601 THRU 0610	Takeoff, Hover, and Landing Indicator (TOLIND) 1 = User inputs the required thrust-to-weight ratio. Airplane will use: a. Max power from lift engines before augmenting with primary engines.

b. Only power from primary engines if LFTIND = 0.

2 = User inputs the required thrust-to-weight ratio. Airplane uses equal percentages of power from lift and primary engines. DO NOT INPUT TOLIND = 2 IF LFTIND = 0.

3 = User inputs req'd fraction of max power.

0611 THRU 0620 Atmosphere Indicator for SGTIND = 2 (ATMIN2)

0 = Standard atmosphere

1 = Non-standard atmos. User inputs single point value for increment in ambient temp. above the standard day value.

2 = Non-standard atmos. User inputs table of ambient temp. ratios as a function of alt.

0621 THRU 0630 Primary Eng Power (or Thrust) Factor (PFET2)

Required when TOLIND = 3 (No input when TOLIND = 1 or 2).

0631 THRU 0640 Ambient Temperature Increment (TIN2)

[DEG FARENHEIT]; Used for engine sizing at Takeoff conditions (No input if ATMIND = 0 or 2).

0641 THRU 0650 Lift Engine Thrust Fraction (FLET2)

Req'd if TOLIND=3 (No input if TOLIND=1,2)

0651 THRU 0660 Thrust-to-Weight Ratio for Takeoff (ENT)

(No input when TOLIND = 3)

0661 THRU 0670 Step Size for Hover (DELTH)

[HRS]

0671 THRU 0680 Power Turbine Speed Ratio (AN2M2)

Ratio of operating power turbine speed to maximum power turbine speed {input for both primary and auxiliary independent engines in performance segment 2, TAKEOFF, HOVER, LANDING} (No input if N2IND = 0,1).

0681 THRU 0690	Incremental Time for Hover (STH) [HRS]
2321 THRU 2330	Vertical Rate of Climb for Takeoff (VRCTO) [FT/MIN]

S. CLIMB INFORMATION {SGTIND = 3}

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0691 THRU 0700	Climb Indicator (CLMIND) 1 = Maximum rate of climb 2 = Climb at constant equivalent airspeed 3 = Climb at constant Mach number 4 = Climb at constant true airspeed
0701 THRU 0710	Mach, Equiv. Airspeed or True Airspeed (EMACH) [KTS]; (No input when CLMIND = 1).
0711 THRU 0720	Climb Segment Atmosphere Indicator (ATMIN3) 0 = Standard atmosphere 1 = Non-standard atmos. User inputs single point value for increment in ambient temp. above the standard day value. 2 = Non-standard atmos. User inputs table of ambient temp. ratios as a function of alt.
0721 THRU 0730	Step Size for Climb Segment (DELH3) [FT]
0731 THRU 0740	Ambient Temperature Increment (TIN3) [DEG FARENHEIT]; Used for sizing engine during climb (No input when ATMIND = 0,2).
0741 THRU 0750	Max Altitude for Climb or Alt. Transfer (HMAX) [FT]

0751 THRU 0760	Climb Segment Power Indicator (POWCLI) 0 = Maximum power 1 = Military power 2 = Normal power
0761 THRU 0770	Max Body Attitude Angle for Climb (THEMAX) [DEG]
0771 THRU 0780	Power Turbine Speed Ratio (AN2M3) Ratio - operating pwr turbine speed to max pwr turbine speed {input for both primary and auxillary independent eng. in seq. 3, CLIMB}. (No input if N2IND = 0 or 1).
0781 THRU 0790	Profile Drag Increase During Climb (DCLIMB)
0791 THRU 0800	Incremental Normal Load Factor (ENCLIMB) For energy-maneuverability calculations (Nominally set equal to 0.0).

T. CRUISE INFORMATION {SGTIND = 4}

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0801 THRU 0810	Cruise Indicator (CRSIND) 1 = Cruise at cruise power. 2 = Cruise at constant true airspeed. 3 = Cruise at speed for best specific range. 4 = Cruise at speed for 99% of best specific range. 5 = Cruise-climb (constant acft wt to ambient press ratio) at speed for best specific range. 6 = Cruise-climb (constant airplane weight to ambient pressure ratio) at speed for 99% of best specific range.

0811 True Airspeed or Headwind (VIN)
THRU
0820 [KTS]; Input true airspeed if CRSIND = 2; Input headwind when CRSIND = 3 thru 6.

0821 Cruise Segment Atmosphere Indicator (ATMIN4)
THRU
0830 0 = Standard atmosphere

1 = Non-standard atmos. User inputs single point value for increment in ambient temp. above the standard day value.

2 = Non-standard atmos. User inputs table of ambient temp. ratios as a function of alt.

0831 Step Size for Cruise Segment (DELR)
THRU
0840 [NAUTICAL MILES]

0841 Ambient Temperature Increment (TIN4)
THRU
0850 [DEG FARENHEIT]; Used for sizing engine during cruise (No input if ATMIND = 0,2).

0851 Range at End of Cruise Segment (RMAX)
THRU
0860 [NAUTICAL MILES]

0861 Cruise Segment Power Indicator (POWCRU)
THRU
0870 0 = Maximum power

1 = Military power

2 = Normal power

0871 Number of Primary Engines Shutdown (ENPSD)
THRU
0880 During cruise segment

0881 Power Turbine Speed Ratio (AN2M4)
THRU
0890 Ratio of operating power turbine speed to maximum power turbine speed {input for both primary and auxiliary independent engines in performance segment 4, CRUISE}. (No input if N2IND = 0 or 1).

0891 THRU 0900	Profile Drag Increase (DLCDCR) [SQ. FT.]; Drag increase during cruise due to engines being shut down (based on wing planform area).

U. DESCENT INFORMATION {SGTIND = 5}

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
0901 THRU 0902	Descent Indicator (DESIND) 1 = Descend at maximum speed, terminal range specified. 2 = Descend at maximum speed, terminal range not specified. 3 = Descend at idle power, terminal range specified. 4 = Descend at idle power, terminal range not specified. 5 = Descend at constant equivalent airspeed, terminal range specified. 6 = Descend at constant equivalent airspeed, terminal range not specified. 7 = Descend at constant Mach number, terminal range specified. 8 = Descend at constant Mach number, terminal range not specified.
0911 THRU 0920	Mach, Equiv. Airspeed or True Airspeed (EMACH) [KTS]; (No input if DESIND = 1,2,3,or,4).
0921 THRU 0930	Descent Segment Atmosphere Indicator (ATMIN5) 0 = Standard atmosphere 1 = Non-standard atmos. User inputs single point value for increment in ambient temp. above the standard day value. 2 = Non-standard atmos. User inputs table of ambient temp. ratios as a function of alt.

0931 Minimum Body Attitude Angle, Descent (THEMIN)
THRU
0940 [DEG]

0941 Ambient Temperature Increment (TIN5)
THRU
0950 [DEG FARENHEIT]; Used for sizing engine during descent (No input if ATMIND = 0,2).

0951 Step Size for Descent (DELH5)
THRU
0960 [FT]

0961 Range at End of Descent (RMAX5)
THRU
0970 [NM]; (No input when DESIND = 2,4,6,8).

0971 Minimum Altitude During Descent (HMIN)
THRU
0980 [FT]

0981 Power Turbine Speed Ratio (AN2M5)
THRU
0990 Ratio of operating power turbine speed to maximum power turbine speed {input for both primary and auxiliary independent engines in performance seg. 5, DESCENT} (No input if N2IND = 0 or 1).

0991 Profile Drag Increase During Descent (CLCDDS)
THRU
1000 Used to simulate drag brakes.

V. LOITER INFORMATION {SGTIND = 6}

1001 Loiter Indicator (DNIRTL)
THRU
1010 0 = Loiter mission is used in reserve fuel calculation (gross wt reset after loiter).

1 = Loiter mission used as part of basic mission profile (gross weight not reset).

1011 Step Size for Loiter (DELST)
THRU
1020 [HRS]

1021 Atmosphere Indicator for SGTIND = 2 (ATMIN2)
THRU
1030 0 = Standard atmosphere

1 = Non-standard atmos. User inputs single point value for increment in ambient temp. above the standard day value.

2 = Non-standard atmos. User inputs table of ambient temp. ratios as a function of alt.

1031 THRU 1040	Incremental Time for Loiter (STL) [HRS]
1041 THRU 1050	Ambient Temperature Increment (TIN6) [DEG FARENHEIT]; Used for engine sizing at LOITER conditions (No input when ATMIND = 0 or 2).
1051 THRU 1060	Number of Primary Engines Shutdown (ENPSDL) During loiter segment
1061 THRU 1070	Power Turbine Speed Ratio (AN2M6) Ratio of operating power turbine speed to maximum power turbine speed {input for both primary and auxiliary independent engines in performance segment 6, LOITER}. (No input if N2IND = 0 or 1).
1071 THRU 1080	Increase in Planform Drag (DLOITR) During loiter segment.
1081 THRU 1090	Wing Area Increase (RSW) Due to flap extension. This is the ratio of the wing loading of the wing and flap to the wing loading of the wing alone.

W. CHANGE IN FUEL WEIGHT {SGTIND = 7}

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
1101 THRU 1110	Fuel Weight Increment (DLTAWF) [LBS]
1121 THRU 1130	Incremental Time for Fuel Weight Change (STFW) [HRS]

X. CHANGE IN PAYLOAD WEIGHT {SGTIND = 8}

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
1131 THRU 1140	Payload Weight Increment (DELWPL) [LBS]
1141 THRU 1150	Incremental Time for Payload Wt Change (STPW) [HRS]

Y. TRANSFER ALTITUDE {SGTIND = 9}

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
1111 THRU 1120	Final Altitude (HFIN) [FT]; Final alt. if HOPTIND = 0 (LOC 0018) or max altitude if HOPTIND = 1.

Z. CHANGE FUEL OR CHANGE PAYLOAD

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
1151	Weight Indicator (WGTIND) 0 = Restriction on maximum airplane weight. Weight cannot exceed gross weight. 1 = No restriction on airplane weight (will only apply when running performance calculations).

AA. GENERAL PERFORMANCE INFORMATION (SGTIND = 11)

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
2201 THRU 2210	Gross Weight Indicator (GWIND) 1 = User inputs the incremental change in gross weight into LOC 2211. 2 = User inputs gross weight into LOC 2211.
2211 THRU 2220	Increment in Gross Weight/Gross Weight (GWP) [LBS]; For GWIND = 0, input the increment

in gross weight; For GWIND = 1, input the gross weight value.

2221 General Perform. Atmosphere Indicator (ATMIN7)
THRU
2230 0 = Standard atmosphere

1 = Non-standard atmos. User inputs single point value for increment in ambient temp. above the standard day value.

2 = Non-standard atmos. User inputs table of ambient temp. ratios as a function of alt.

2241 Ambient Temperature Increment (TIN7)
THRU
2250 [DEG FARENHEIT]; Used for engine sizing at GENERAL PERFORMANCE conditions (No input when ATMIND = 0 or 2).

2251 Profile Drag Increase (DLCDCR)
THRU
2260 [SQ. FT.]; Drag increase during cruise due to engines being shut down (based on wing planform area).

2261 Altitude (AHOP)
THRU
2270 [FT]

2271 Thrust-to-Weight Ratio for Takeoff (ENT)
THRU
2280

2281 Power Turbine Speed Ratio (AN2M7)
THRU
2290 Ratio of operating power turbine speed to max. power turbine speed {input for both prim. and auxiliary independent engines in performance segment 11, TAKEOFF - GENERAL PERFORMANCE}.

2291 Velocity Increment (DELVP)
THRU
2300 [KTS]

2301 Maximum Velocity (VMAXP)
THRU
2310 [KTS]

2311 THRU 2320 Power Turbine Speed Ratio (AN2M8)

Ratio of operating power turbine speed to max. power turbine speed {input for both prim. and auxiliary independent engines in perform. seg. 11, CRUISE - GEN PERFORM}.

BB. ENGINE CYCLE DATA; NON-STANDARD PERFORMANCE

LOCATION DATA DESCRIPTION (FORTRAN NAME)

1201 Primary Engine Fuel Flow Indicator (WDTIND)

0 = No primary engine fuel flow cutoff

1 = Primary engine fuel flow cutoff

1202 Primary Engine N1 Indicator (AN1IND)

0 = No primary engine limit for the gas generator shaft speed (N1)

1 = Primary engine limit for the gas generator shaft speed (N1)

1203 Primary Engine Referred N1 Indicator (AN3IND)

0 = No primary engine referred N1 limit

1 = Primary engine referred N1 limit

1204 Primary Engine N2 Indicator (AN2IND)

0 = No primary engine N2 limit. Primary eng. operates at optimum power turbine speed (N2) value.

1 = Limit imposed on primary engine N2. Eng. operates at optimum power turbine speed (N2) value.

2 = Limit imposed on primary engine N2. Eng. operates at known value of N2 (in general, a non-optimum value).

1205 Torque Limit Indicator (QIND)

0 = No torque limit

1 = Torque limit

1206 Reynold's No. Correction Indicator (RNOIND)

0 = No Reynold's no. corrections

1 = Reynold's no. corrections

1207
THRU
1216 Reynold's Number Correction Factor (PRN)

Reynold's no. correction for gas generator shaft speed (No input if RNOIND = 0).

1217 Lift Eng. Fuel Flow Indicator (VWDIND)

0 = No fuel flow limit on the lift engine.

1 = Fuel flow limit imposed on the lift eng.

1218 Lift Engine N1 Indicator (VN1IND)

0 = No limit on the lift engine gas generator shaft speed (N1).

1 = Limit imposed on the lift engine gas generator shaft speed (N1).

1219 Lift Eng. Pwr Turbine Speed Indicator (VN2IND)

0 = No limit on the lift engine power turbine speed (N2).

1 = Limit imposed on the lift engine power speed (N2).

1220 Primary Eng. Referred Fuel Flow Cutoff (WMAX)

(No input if WDTIND = 0)

1221 Primary Engine Gas Generator RPM Limit (A1MAX)

Ratio of max gas generator RPM to RPM at max static power, standard sea level (No input when AN1IND = 0).

1222 Prim. Eng. Referred Gas Gen. RPM Limit (A3MAX)

Simulates a restriction on compression speed (No input when AN3IND = 0).

1223 Primary Eng. Power Turbine Speed Limit (A2MAX)

Ratio of max power turbine speed (N2) to

	power turbine speed at max static power, standard sea level conditions (No input when AN2IND = 0).
1224	Torque Limit (QMAX) Ratio of max torque limit to torque developed at static conditions, standard sea level.
1225 THRU 1234	Engine Power Correction Factor (RNE) To account for Reynold's number effects (No input when RNOIND = 0).
1235	Lift Eng. Referred Fuel Flow Cutoff (WLMAX) (No input when VWDIND = 0)
1236	Lift Engine Gas Generator RPM Limit (A1MAX) Ratio of max gas generator RPM (N1) to RPM at max static power, standard sea level (No input when VN1IND = 0).
1237	Lift Engine Power Turbine Speed Limit (AL2MAX) Ratio of max power turbine speed (N2) to power turbine speed at max static power, standard sea level (No input if VN2IND=0).
1238 THRU 1247	Output Shaft Speed Correction Factor (A2NO) Ratio of operating power turbine speed to optimum power turbine speed (input when N2IND = 2 and non-standard correction is desired). See additional info in Ref. 3, page 5-39. (No input if N2IND = 0 or 1).
1248 THRU 1257	Output Power Correction Factor (PNZ) Input if N2IND = 2 and non-standard correction is desired. Ratio of power available at specified power turbine speed to power available at the optimum power turbine speed (No input if N2IND = 0,1).

CC. PRIMARY ENGINE CYCLE INFORMATION

```
*************************************************************
*   LOCATIONS 1301 - 1565 ARE NOT REQUIRED IF A STANDARD    *
*             PRIMARY ENGINE CYCLE IS SELECTED              *
*************************************************************
```

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
1301	Cycle Number (CYCPRL) MUST match engine cycle no. in LOC 0201.
1302	Primary Engine Weight Factor (SK3) [LB/HP] if ENGIND = 0; [LB/LB-THRUST] if ENGIND = 1 or 2.
1303	Primary Engine Weight Factor (SK4) [LBS]
1304	Primary Engine Dimensional Factor (XI4) [FT/LB-THRUST] if ENGIND = 1 or 2; [FT/SQRT(SHP)] if ENGIND = 0.
1305	Ground Idle Turbine Inlet Temperature (TGI) [DEG RANKINE]
1306	Flight Idle Turbine Inlet Temperature (TFI) [DEG RANKINE]
1307	Normal Power Turbine Inlet Temp. (TNRP) [DEG RANKINE]
1308	Military Power Turbine Inlet Temp. (TMIL) [DEG RANKINE]
1309	Maximum Power Turbine Inlet Temp. (TMAX) [DEG RANKINE]
1310	Number of Referred Temperatures (UNTS) Number of values in LOC 1311 - 1318.

1311 THRU 1318	Referred Turbine Temperatures (TSHP) [DEG RANKINE]; Ratio of turbine temp. to ambient temperature ratio.
1319	Number of Mach No. (UMS) Number of values in LOC 1320 - 1325.
1320 THRU 1325	Mach Number Values (AMSHP) Referred thrust tbl values (LOC 1326-1373)
1326 THRU 1373	Referred Thrust or Horsepower Values (SHPAV) (Table must be at least 3 X 3 in size)
1374	Number of Referred Temperatures (UNTW) Number of values in LOC 1375 - 1382.
1375 THRU 1382	Referred Turbine Temperature Values (TWD) [DEG RANKINE]; Ratio of turbine temp. to ambient temperature ratio.
1383	Number of Mach Numbers (UMW) Number of values in LOC 1384 - 1389.
1384 THRU 1389	Mach Number Values (AMWD) Values for the referred fuel flow table (LOC 1390 - 1437).
1390 THRU 1437	Primary Eng. Referred Fuel Flow Rate (FWDOT) (Table must be at least 3 X 3 in size)
1438	Number of Referred Temperatures (UNT1) Number of values in LOC 1439 - 1446.
1439 THRU 1446	Referred Turbine Temperatures (TN1) [DEG RANKINE]; Ratio of turbine temp. to ambient temperature ratio.
1447	Number of Mach No. (UNM1) Number of values in LOC 1448 - 1453.

1448 THRU 1453 Mach Number Values (AM1)

Values for the referred gas generator RPM limit table (LOC 1454 - 1501).

1454 THRU 1501 Referred Gas Generator RPM Speed Limit (AONE)

(Table must be at least 3 X 3 in size)

1502 Number of Referred Temperatures (UNT2)

Number of values in LOC 1503 - 1510.

1503 THRU 1510 Referred Turbine Temperatures (TN2)

[DEG RANKINE]; Ratio of turbine temp. to ambient temperature ratio.

1511 Number of Mach No. (UNM2)

Number of values in LOC 1512 - 1517.

1512 THRU 1517 Mach Number Values (AM2)

Values for the referred power turbine RPM limit table (LOC 1518 - 1565).

1518 THRU 1565 Referred Gas Generator RPM Speed Limit (ATWO)

(Table must be at least 3 X 3 in size)

DD. LIFT ENGINE CYCLE INFORMATION

```
***************************************************************
* LOCATIONS 1601 - 1672 ARE NOT REQUIRED IF A STANDARD LIFT *
*        ENGINE CYCLE IS SELECTED OR IF LFTIND = 0          *
***************************************************************
```

1601 Cycle Number (CYCLFL)

MUST match lift eng. cycle no. - LOC 0218.

1602 Lift Engine Weight Factor (SK1)

[LB/LB THRUST]

1603 Lift Engine Weight Factor (SK2)

[LBS]

1604	Lift Engine Dimensional Factor (XI1) [FT/SQRT(LB THRUST)]
1605	Lift Engine Dimensional Factor (XI2) [FT]
1606	Lift Engine Dimensional Factor (XI3) [FT/SQRT(LB THRUST)]
1607	Ground Idle Turbine Inlet Temperature (TLGI) [DEG RANKINE]
1608	Max Power Turbine Inlet Temperature (TLMAX) [DEG RANKINE]
1609 THRU 1616	Referred Turbine Temperatures (TF) [DEG RANKINE]; Ratio of turbine temp. to ambient temperature ratio.
1617 THRU 1624	Values of Referred Thrust (FAVL)
1625 THRU 1632	Referred Turbine Temperatures (TFW) [DEG RANKINE]; Ratio of turbine temp. to ambient temperature ratio.
1633 THRU 1640	Values of Referred Fuel Flow Rate (FWDOT)
1641 THRU 1648	Referred Turbine Temperatures (TF1) [DEG RANKINE]; Ratio of turbine temp. to ambient temperature ratio.
1649 THRU 1656	Referred Gas Generator Speed Limit (FONE)
1657 THRU 1664	Referred Turbine Temperatures (TF2) [DEG RANKINE]; Ratio of turbine temp. to ambient temperature ratio.

1665 THRU 1672	Referred Power Turbine Speed Limit (FTWO)

EE. ECONOMICS

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
1675	Inflation Factor (SPAC15(3)) Base year is 1967.
1676	Profit Factor (SPAC15(4)) Expressed as a no. greater than 1.0. For ex., 1.1 would represent a 10% profit.
1677	No. of Prototype Aircraft (SPAC15(5)) Number in development program.
1678	No. of Production Aircraft (SPAC15(6))
1679	Avionics and Miscellaneous Costs (SPAC15(7)) Per prototype aircraft.
1680	No. of Ground Test Articles (SPAC15(8))
1681	No. of Flight Test Hours (SPAC15(9))
1682	Trainer and Misc. RDT&E Costs (SPAC15(10))
1683	Avionics Costs (SPAC15(11)) Per production aircraft in 1967 dollars.
1684	Cost of Fuel (SPAC15(12)) [DOLLARS/LB]
1685	Cost of Oil (SPAC15(13)) [DOLLARS/LB]
1686	Hull Insurance Rate (SPAC15(14))
1687	Maintenance Labor Rate (SPAC15(15)) [DOLLARS/HR]

1688	Time Between Engine Overhauls (SPAC15(16)) [HRS]
1689	Time Between Dynamic Systems Overhauls (SPAC15(17)) [HRS]
1690	Dynamic Systems Indicator (SPAC15(18)) 1 = Dynamic system used during entire flight. 2 = Dynamic system used during takeoff/landing only.
1691	Annual Interest Rate on Capital (SPAC15(19))
1692	Depreciation Period (SPAC15(20)) [YRS]
1693	Residual Value (SPAC15(21)) [DOLLARS]
1694	Annual Utilization (SPAC15(22)) [HRS]
1695	Customer Aircraft Buy (SPAC15(23))

FF. HOVER PERFORMANCE MAP

LOCATION	DATA DESCRIPTION (FORTRAN NAME)
2351	Number of Thrust Coefficient to Propeller Solidity Ratios (CTSGNO) Number of values in LOC 2352 - 2361.
2352 THRU 2361	Thrust Coeff. to Solid. Ratio Values (CTOSIG) (Input at least three (3) values)
2362	Number of Tip Mach Number Values (TPMNO) Number of values in LOC 2363 - 2368.

2363 THRU 2368	Tip Mach Number Values (TIPM) (Input at least three (3) values)
2369 THRU 2428	Figure of Merit Table (FMER) Figure of merit values as a function of thrust coefficient to prop solidity ratios and tip Mach numbers.

GG. PROPELLER/FAN PERFORMANCE DATA

****
* LOCATIONS 1700 - 2142 ARE REQUIRED WHEN ETAIND = 1 or 3 *
****

1700	Propeller/Fan Table Number (PROPCY) MUST match value for CYPROP (LOC 0256).
1701	Number of Advance Ratios or Mach No. (XPXNO) Number of values in LOC 1702 - 1721
1702 THRU 1721	Prop Advance Ratios or Mach No. Values (XPJ) (Input at least three (3) values of prop advance ratio or Mach number)
1722	Number of Propeller Thrust Coefficients or Referred Thrust Coefficients (CPPNO) Number of values in LOC 1723 - 1742.
1723 THRU 1742	Propeller Thrust Coefficients or Referred Thrust Coefficients (CTPROP) (Input at least three (3) values of prop thrust coeff. or referred thrust coeff.)
1743 THRU 2142	Propeller or Fan Power Coefficients (CPPROP) Prop Power Coeff: Array input as a func. of advance ratio and prop thrust coeff. Fan Power Coefficients: Array input as a function of Mach number and referred thrust coefficient.

HH. DESCRIPTION OF SAMPLE DATA VALUES

The following is an actual data file used to study an eight passenger tilt rotor aircraft design. Each data value used in the input data file is listed below and described.

II. LISTING OF DATA LOCATION/VALUES

LOC	VARIABLE	VALUE	SIGNIFICANCE OF DATA VALUE
0001	OPTIND	1.0	Sizing run
0002	TNIRPK	0.0	Standard output
0003	DRGIND	0.0	Program calculates drag rise due to compressibility effects
0004	OSWIND	1.0	Program calculates the Oswald's efficiency factor
0005	PDMIND	3.0	Input diameter and thrust coeff. to solidity ratio
0006	FDMIND	2.0	Input desired seating capacity, seat width and pitch, number and width of aisles, number of seats abreast for tourist and first class, galley and lavatory size; Program calculates fuselage size
0007	WDMIND	0.0	Input wing loading & aspect ratio
0008	HTIND	2.0	Input horizontal tail area
0009	VTIND	2.0	Input vertical tail area
0010	FIXIND	0.0	Input level of maximum power or thrust (fixed engine size)
0011	ENGIND	0.0	Turboshaft engine
0012	ESZIND	0.0	Engines sized for takeoff only
0013	LFTIND	0.0	No separate lift propulsion engine
0014	WG00	13000.0	First guess at gross weight [LBS]

0015	HOO	0.0	Start altitude [FT]
0016	ROO	0.0	Start range [NM]
0017	STOO	0.0	Start time [HRS]
0018	HOPTIN	0.0	Input desired cruise segment alt.
0019	VLMIND	0.0	Airspeed limited to 250 kts EAS at altitudes of 10,000 ft or less
0020	EMMO	0.575	Max operating Mach number
0021	VMO	260.0	Max operating equivalent airspeed [KTS]
0022	VDIV	300.0	Design dive speed [KTS]
0023	EMLF	4.0	Maneuver load factor
0024	CK1		Default = 1.0 (no reserve fuel)
0025	DELWF		Default = 0.0 (no fixed fuel for reserves or other use)
0026	CKFF		Default = 1.0 (use nominal engine fuel)
0027	SGTIND	1.0	Taxi
0028	SGTIND	2.0	Takeoff
0029	SGTIND	3.0	Climb
0030	SGTIND	4.0	Cruise
0031	SGTIND	5.0	Descent
0032	SGTIND	2.0	Land
0033	SGTIND	1.0	Taxi
0034	SGTIND	9.0	Transfer altitude
0035	SGTIND	6.0	Loiter
0036	SGTIND	100.0	End of case
0037 THRU 0076	SGTIND SGTIND		Not used

0077 THRU 0093			Not assigned for program
0094	SPACE1(18)	1.0	High wing location for 3-View drawing
0095	SPACE1(19)		Default = 0.0
0096	SPACE1(20)		Default = 0.0
0097	SPACE1(21)		Default = 0.0
0098	SPACE1(22)	0.0	Any value greater than 0.0 will generate the 3-View drawing; NOT available at NPS as of this writing
0099			Not assigned for program
0100		1.0	NPS modification; output will be abbreviated and a maximum of 80 characters wide for compatibility with THESIS2.
0101	DAM2	6.6	Wing aspect ratio
0102	DAM3		WDMIND = 0 (LOC 0007), therefore no input
0103	EYEW	3.0	Wing incidence angle [DEG] measured with respect to fuselage
0104	TCR	0.223	Wing root thickness-chord ratio
0105	TCT	0.223	Wing tip thickness-chord ratio
0106	DAM4	72.45	Wing loading [LBS/SQ FT] at design gross weight
0107	DLMC4	-6.5	Quarter chord mean sweep angle [DEG]; (The XV-15 has a forward swept wing for prop clearance during flapping)
0108	SLM	1.0	Taper ratio of wing (tip chord/ root chord)
0109	ARHT	3.27	Horizontal tail aspect rato
0110	SAH	0.0	Horizontal tail is on vertical

			tail root chord
0111	ELTH	22.4	Horizontal tail moment arm [FT]
0112	TLCT	0.15	Horizontal tail mean thickness to chord ratio
0113	VBARH		HTIND = 2 (LOC 0008), therefore no input
0114	SLMH	1.0	Horizontal tail taper ratio
0115	AAW11	50.25	Horizontal tail planform area [SQ FT]
0116	SR	.08	Prop blade attachment distance measured from the centerline of the hub and expressed as a fraction of the propeller radius
0117	YCL		WDMIND = 0 (LOC 0007), therefore no input
0118	ZETA1		WDMIND = 0 (LOC 0007), therefore no input
0119	ZETA2		WDMIND = 0 (LOC 0007), therefore no input
0120	DLSWSW		Default = 0.0 (no protrusions such as landing gear)
0121	HF		FDMIND = 2 (LOC 0006), therefore no input
0122	DAM5		FDMIND = 2 (LOC 0006), therefore no input
0123	ELPD	1.2	Nose section fineness ratio
0124	ELTD	2.5	Tail section fineness ratio
0125	ELC	18.8	Cabin section length of constant diameter [FT]
0126	ELRW	0.0	Length of ramp well [FT]
0127	DAM6		FDMIND = 2 (LOC 0006), therefore no input
0128	SWF		FDMIND = 2.0 (LOC 0006); no input

0129	ARVT	2.33	Vertical tail aspect ratio
0130	ELTV	23.2	Vertical tail moment arm [FT]
0131	TCVT	.09	Vertical tail mean thickness to chord ratio
0132	VBARV		VTIND = 2 (LOC 0009), therefore no input
0133	SLMV	0.587	Vertical tail taper ratio
0134	AAW12	50.5	Vertical tail area [SQ FT]
0135	YMG	0.0	Position of main landing gear measured outboard from the side of the body and expressed as a fraction of wing semi-span
0136	YP	1.0	Mean position of primary engines measured outboard from airplane centerline and expressed as a fraction of wing semi-span
0137	YL		LFTIND = 0 (LOC 0013), therefore no input
0138	EPSLON		LFTIND = 0 (LOC 0013), therefore no input
0139	AZETA1	0.0758	Primary engine nacelle dimension factor
0140	AZETA2	0.0	Primary engine nacelle dimension factor
0141	AZETA3	0.233	Primary engine nacelle dimension factor
0142	SKIP(1)	0.25	Rotor thickness to chord ratio at 0.25R
0143 THRU 0150			Not assigned in program
0151	DNI1GN	0.0	Galley area calculated by program
0152	AGLLEY	0.0	Area of galley (e.g. no galley)
0153	ANPX1	0.0	No first class seats

0154	ANAB1		Default = 0
0155	ANISL1		Default = 0
0156	WSEAT1		Default = 0
0157	PSEAT1		Default = 0
0158	WAISL1		Default = 0
0159	DNIVAL	1.0	User inputs number of lavatories
0160	ANLAVS	1.0	Number of lavatories = 1
0161	ANPXT	8.0	Passenger capacity in the tourist section
0162	ANABT	2.0	No. of seats abreast in tourist
0163	ANISLT	1.0	No. of aisles in tourist
0164	WSEATT	21.0	Width of seats in tourist [IN]
0165	PSEATT	41.0	Seat pitch [IN]
0166	WAISLT	17.0	Aisle width [IN]
0167	SPACE2(1)	0.0	No. in flight deck crew
0168	SPACE2(2)	0.0	No of flight attendants
0169 THRU 0199			Not assigned in program
0200	ETAIND	2.0	Propulsive performance calculated by program
0201	CYCPRP	1.78	Primary engine cycle number
0202	DAM7	2920.0	Primary engine maximum static horsepower [HP]; total for all engines
0203			Not used for turboshaft engines
0204	ENP	2.0	Number of primary engines
0205			Not used for turboshaft engines
0206	ETAT	0.95	Transmission efficiency

0207	HES	0.0	Takeoff altitude [FT]
0208	SENE	1.098	Thrust-to-weight ratio
0209	TINY	0.0	Ambient temperature increment for takeoff [DEG FARENHEIT]
0210	AN2TO	1.0	Ratio of operating power turbine speed to max power turbine speed
0211	ENPO		FIXIND = 0 (LOC 0010), therefore no input
0212	ENLO		FIXIND = 0 (LOC 0010), therefore no input
0213	POWESI		FIXIND = 0 (LOC 0010), therefore no input
0214	HC		FIXIND = 0 (LOC 0010), therefore no input
0215	VC		FIXIND = 0 (LOC 0010), therefore no input
0216	ATMIY		FIXIND = 0 (LOC 0010), therefore no input
0217	AN2CR		FIXIND = 0 (LOC 0010), therefore no input
0218 THRU 0221			Not used for turboshaft engines
0222			Not assigned for program
0223	ENR	2.0	Number of propellers
0224	VT	817.7	Propeller tip speed [FT/SEC]
0225	WGA		PDMIND = 3 (LOC 0005), therefore no input
0226	DI	25.0	Propeller diameter [FT]
0227	CTSIG	0.123	Thrust coefficient to propeller solidity ratio
0228	AF	72.92	Activity factor per blade
0229	BLDN	3.0	Number of blades on propeller

0230	CLEYE	0.25	Propeller integrated design lift coefficient
0231 THRU 0233			ETAIND = 2 (LOC 0200), therefore no input
0234	ETAP5	0.75	Descent propeller efficiency
0235 THRU 0256			ETAIND = 2 (LOC 0200), therefore no input
0257	XMSND	0.0	Transmission sized at fraction of installed power
0258	XMSMRT	1.0	Fraction of installed power for sizing transmission
0259	DSHPAC	15.0	Accessory horsepower [HP]
0260	SHPTO		Ratio of eng. SHP to primary eng. max static HP (LOC 0202); used for sizing eng; default = 1.0
0261	VRCRC		Takeoff vertical rate of climb [FT/MIN]
0262	CKRC		Climb pwr multiplicative constant (default is 2.0)
0263 THRU 0300			Not assigned in program
0301 THRU 0304	CDVTI CDLNI		Default = 0.0
0305	DELCD	0.0138	Profile drag increment based on wing planform area
0306	DAM10		OSWIND = 1 (LOC 0004), therefore no input
0307	DELFE	9.08	Equiv. flat plate area [SQ FT]
0308	TLLN	2.0	Number of pairs of values in the table of wing profile drag coeff. (LOC 0335 - 0342) versus lift coeff. (LOC 0317 - 0324)

0309	TENN		DRGIND = 0.0 (LOC 0003); no input
0310	TCLZN		DRGIND = 0.0 (LOC 0003); no input
0311	CKLN		Default = 0.0
0312	CKW	1.0	Wing multiplicative drag factor
0313	CKN	1.0	Primary nacelle multiplicative drag factor
0314 THRU 0316			Default = 0.0
0317	TBCL1(1)	0.0	Wing lift coeff. value
0318	TBCL1(2)	4.0	Wing lift coeff. value
0319 THRU 0324			Not used
0325 THRU 0329			DRGIND = 0.0 (LOC 0003); no input
0330	RECI	0.2E+07	Mean Reynold's number per foot for mission
0331	CSALF	6.28	Two dimensional lift coeff. slope
0332	ALPHL	-1.0	Zero lift angle of attack [DEG]
0333	XCPS	0.3	Nondimensional position along the chord
0334	XCTCM	0.35	Nondimensional position along the chord at maximum t/c ratio
0335	TBCDWI(1)	0.0	Wing profile drag coeff. value
0336	TBCDWI(2)	0.0	Wing profile drag coeff. value
0337 THRU 0342			Not used
0343 THRU 0384			DRGIND = 0.0 (LOC 0003); no input

0385 THRU 0393			Not used
0394	SPACE4(10)	4.0	No. of stages in main rotor drive
0395	SPACE4(11)		Blade fold penalty; default = 1.0 (no fold)
0396	SPACE4(12)	61.0	Hub weight coefficient
0397	SPACE4(13)	0.12	Hub material/development factor
0398	SPACE4(14)	44.0	Blade weight coefficient
0399	SPACE4(15)	2.2	Hingeless rotor system
0400	OWE1		OPTIND = 1 (LOC 0001); no input
0401	WFE	2477.0	Weight of fixed equipment [LBS]
0402	WFUL	716.0	Weight of fixed useful load [LBS]
0403	WPL	0.0	Weight of payload [LBS]
0404	SKCC	15.67	Cockpit controls constant
0405	SKFW	.016	Fixed-wing controls constant
0406	SKH	0.0	System and hydraulics constant
0407	SKSAS	165.0	Factor for stability augmented system
0408	SKTM	0.0162	Tilting mechanism constant
0409	SKUC	0.779	Upper control mechanisms constant
0410 THRU 0415	CK15 CK20		Default = 1.0
0416	THN		ATMIND is not set equal to 2.0 during any segment; no input
0417 THRU 0419	DELWFZ DELWST		Default = 0.0
0420	SKP	162.0	Body group weight adjustment factor

0421	SKLES		LFTIND = 0.0 (LOC 0013); no input
0422	SKLG	0.04	Alighting gear weight expressed
0423	SKMG	0.80	Ratio of main gear weight to gross weight
0424	SKTL	1.0	Tail load adjustment factor
0425	SKWF	0.6	Wing bending relief moment adjustment factor
0426	SKWW	350.0	Wing type weight adjustment factor
0427	SKY	0.195	Pitch radius of gyration [FT]
0428	SKZ	0.13	Yaw radius of gyration [FT]
0429	SKPES	0.3422	Primary engine section weight

0421	SKLES		LFTIND = 0.0 (LOC 0013); no input
0422	SKLG	0.04	Alighting gear weight expressed as a percentage of gross weight
0423	SKMG	0.80	Ratio of main gear weight to gross weight
0424	SKTL	1.0	Tail load adjustment factor
0425	SKWF	0.6	Wing bending relief moment adjustment factor
0426	SKWW	350.0	Wing type weight adjustment factor
0427	SKY	0.195	Pitch radius of gyration [FT]
0428	SKZ	0.13	Yaw radius of gyration [FT]
0429	SKPES	0.3422	Primary engine section weight

0453	SKDS	345.0	Drive system weight adjustment factor
0454	SKFS	0.10	Fuel sys. wt. adjustment factor
0455	SKLEI		LFTIND = 0.0 (LOC 0013); no input
0456	SKPEI	0.1654	Primary eng. installation weight factor

0457	SKRP	15.77	Prop. weight adjustment factor
0458	SKVT	1.00	Drive system weight variation adjustment factor
0459 THRU 0465			Default = 1.0
0466 THRU 0475	TBTHE TBTHE		THN = 0.0 (LOC 0416); no input
0476 THRU 0500			Default = 0.0
0501	ATMIN1	0.0	Standard atmosphere for first taxi segment
0502	ATMIN1	0.0	Standard atmosphere for second taxi segment
0503 THRU 0510			Not used
0511	DELTT	0.025	Incremental time for first taxi segment [HRS]
0512	DELTT	0.025	Incremental time for second taxi segment [HRS]
0513 THRU 0520			Not used
0521 THRU 0530	TIN1 TIN1		ATMIN1 = 0.0 (LOC 0501 - 0510); no input
0531 THRU 0540			LFTIND = 0.0 (LOC 0013); no input
0541	AN1M1	0.81	Ratio of operating power turbine speed to max power turbine speed for first taxi segment

0542	AN1M1	0.81	Ratio of operating power turbine speed to max power turbine speed for second taxi segment
0543 THRU 0550			Not used
0551 THRU 0600			Not assigned in program
0601	TOLIND	3.0	User inputs required fraction of maximum power for takeoff segment
0602	TOLIND	3.0	User inputs required fraction of maximum power for landing segment
0603 THRU 0610			Not used
0611	ATMIN2	0.0	Standard atmosphere for takeoff segment
0612	ATMIN2	0.0	Standard atmosphere for landing segment
0613 THRU 0620			Not used
0621	PFET2	1.0	Primary engine power (or thrust) factor for takeoff segment
0622	PFET2	1.0	Primary engine power (or thrust) factor for landing segment
0623 THRU 0630			Not used
0631 THRU 0640			ATMIN2 = 0.0 (LOC 0611 - 0620); no input
0641 THRU 0660			Default = 0.0

0661	DELTH	0.01667	Step size for hover during takeoff segment [HRS]
0662	DELTH	0.01667	Step size for hover during landing segment [HRS]
0663 THRU 0670			Not used
0671	AN2M2	1.0	Ratio of operating power turbine speed to max power turbine speed for takeoff segment
0672	AN2M2	1.0	Ratio of operating power turbine speed to max power turbine speed for landing segment
0673 THRU 0680			Not used
0681	STH	0.01667	Incremental time for hover during takeoff segment [HRS]
0682	STH	0.01667	Incremental time for hover during landing segment [HRS]
0683 THRU 0690			Not used
0691	CLMIND	1.0	Maximum rate of climb during climb segment
0692 THRU 0700			Not used
0701 THRU 0710			CLMIND = 1.0 (LOC 0691); no input
0711	ATMIN3	0.0	Standard atmosphere for climb segment
0712 THRU 0720			Not used
0720	DELH3	1000.0	Step size for climb segment [FT]

0721 THRU 0730			Not used
0731 THRU 0740			ATMIND = 0.0 (LOC 0711); no input
0741	HMAX	15000.0	Max altitude for climb segment [FT]
0742 THRU 0750			Not used
0751	POWCLI	1.0	Climb at military power rating
0752 THRU 0760			Not used
0761	THEMAX	20.0	Max body attitude angle for climb segment [DEG]
0762 THRU 0770			Not used
0771	AN2M3	0.81	Ratio of operating power turbine speed to max power turbine speed for climb segment
0772 THRU 0780			Not used
0781 THRU 0800			Default = 0.0
0801	CRSIND	1.0	Cruise at cruise power
0802 THRU 0810			Not used
0811 THRU 0820			Default = 0.0

0821	ATMIN4	0.0	Standard atmosphere for cruise segment
0822 THRU 0830			Not used
0831	DELR	20.0	Step size for cruise segment [NM]
0832 THRU 0840			Not used
0841 THRU 0850			ATMIN4 = 0.0 (LOC 0821); no input
0851	RMAX	300.0	Range at end of cruise segment
0861	POWCRU	2.0	Cruise at normal power rating
0862 THRU 0870			Not used
0871 THRU 0880			Default = 0.0
0881	AN2M4	0.81	Ratio of operating power turbine speed to max power turbine speed for cruise segment
0882 THRU 0890			Not used
0891 THRU 0900			Default = 0.0
0901	DESIND	1.0	Descend at maximum speed at the terminal range specified
0902 THRU 0910			Not used
0911 THRU 0920			DESIND = 1.0 (LOC 0901); no input

0921	ATMIN5	0.0	Standard atmosphere for the descent segment
0922 THRU 0930			Not used
0931	THEMIN	-20.0	Minimum body attitude angle during descent segment [DEG]
0941 THRU 0950			ATMIN5 = 0.0 (LOC 0921); no input
0951	DELH5	1000.0	Step size for descent segment [FT]
0952 THRU 0960			Not used
0961	RMAX5	300.0	Range at end of descent [NM]
0962 THRU 0970			Not used
0971	HMIN	0.0	Minimum altitude during descent segment [FT]
0972 THRU 0980			Not used
0981	AN2M5	0.81	Ratio of operating power turbine speed to max power turbine speed during descent segment
0982 THRU 0990			Not used
0991 THRU 1000			Default = 0.0
1001	LTRIND	2.0	Loiter performed for reserve fuel calculation

1002 THRU 1010			Not used for this case
1011	DELST	0.1	Step size for loiter segment [HR]
1012 THRU 1020			Not used for this case
1021	ATMIN6	0.0	Standard atmosphere
1022 THRU 1030			Not used for this case
1031	STL	0.3333	Incremental time for loiter [HRS]
1032 THRU 1060			Not used for this case
1061	AN2M6	0.81	Ratio of operating power turbine speed to maximum power turbine speed during loiter segment
1062 THRU 1110			Not used for this case
1111	HFIN	15000.0	Final altitude for transfer altitude segment [FT]
1112 THRU 1151			Not used for this case
1152 THRU 1200			Not assigned for program
1201	WDTIND	1.0	Restriction will be applied to fuel flow
1202	AN1IND	0.0	No restruction on referred N1 limit
1204	AN2IND	2.0	Restriction will be applied to N2; Engine will operate at a known value of N2 (generally non-optimum)

1205	QIND	0.0	No restruction on torque limit
1206 THRU 1219			Not used for this case
1220	WMAX	1.11	Maximum fuel flow will be 11% greater than fuel flow at maximum static thrust, standard sea level
1221	A1MAX	1.04	Gas generator cutoff at 4% over max. sea level gas generator RPM
1222	A3MAX	0.0	No cutoff of referred N1
1223	A2MAX	0.905	Power turbine cutoff at 90.5% of maximum sea level turbine power
1224	QMAX	1.446	Torque cutoff at 44.6% over max. torque developed at sea level, static, standard day conditions
1225 THRU 1257			Not used for this case
1258 THRU 1300			Not assigned for program
1301	CYCPRL	1.78	Propulsion cycle number
1302	SK3	0.36	Primary engine weight Multiplicative factor
1303	SK4	0.00	Primary engine weights additional factor
1304	XI4	0.032	Primary engine dimensional factor
1305	TGI	1650.0	Turbine inlet temperature, ground idle power setting [DEG RANKINE]
1306	TFI	1800.0	Turbine inlet temperature, flight idle power setting
1307	TNRP	2180.0	Turbine inlet temperature, normal power setting
1308	TMIL	2235.0	Turbine inlet temperature, military power setting

1309	TMAX	2280.0	Turbine inlet temperature, maximum power setting
1310	UNTS	7.0	Number of referred temperatures in locations 1311-1318
1311	TSHP	1600.0	Values of referred turbine temp. for the referred thrust or H.P. tables
1312	"	1800.0	
1313	"	2000.0	
1314	"	2200.0	
1315	"	2400.0	
1316	"	2600.0	
1317	"	2800.0	
1318			Not used for this case
1319	UMS	5.0	Number of Mach number values in locations 1320-1325
1320	AMSHP	0.0	Values of Mach number for the referred thrust or H.P. tables
1321	"	0.2	
1322	"	0.4	
1323	"	0.6	
1324	"	0.8	
1325			Not used for this case
1326	SHPAV	0.035	Values of referred thrust or H.P. corresponding to referred temperature location 1311 and Mach numbers found in locations 1320-1324
1327	"	0.075	
1328	"	0.125	
1329	"	0.180	
1330	"	0.240	
1331			Not used for this case
1332	SHPAV	0.330	Values of referred thrust or H.P. corresponding to referred temp. location 1312 and Mach numbers found in locations 1320 - 1324
1333	"	0.375	
1334	"	0.425	
1335	"	0.480	
1336	"	0.534	
1337			Not used for this case
1338	SHPAV	0.630	Values of referred thrust or H.P. corresponding to referred temp. location 1313 and Mach numbers found in locations 1320 - 1324
1339	"	0.670	
1340	"	0.720	
1341	"	0.775	
1342	"	0.835	
1343			Not used for this case

1344	SHPAV	0.920	Values of referred thrust or H.P. corresponding to referred temperature location 1314 and Mach numbers found in locations 1320-1324
1345	"	0.960	
1346	"	1.010	
1347	"	1.065	
1348	"	1.125	
1349			Not used for this case
1350	SHPAV	1.200	Values of referred thrust or H.P. corresponding to referred temp. location 1316 and Mach numbers found in locations 1320 - 1324
1351	"	1.245	
1352	"	1.295	
1353	"	1.350	
1354	"	1.410	
1355			Not used for this case
1356	SHPAV	1.340	Values of referred thrust or H.P. corresponding to referred temp. location 1316 and Mach numbers found in locations 1320 - 1324
1357	"	1.390	
1358	"	1.440	
1359	"	1.495	
1360	"	1.550	
1361			Not used for this case
1362	SHPAV	1.400	Values of referred thrust or H.P. corresponding to referred temp. location 1317 and Mach numbers found in locations 1320 - 1324
1363	"	1.450	
1364	"	1.500	
1365	"	1.550	
1366	"	1.600	
1367 THRU 1373			Not used for this case
1374	UNTW	7.0	Number of referred temperatures in LOC 1375-1382
1375	TWD	1600.0	Values of referred turbine temp. for the referred fuel flow table
1376	"	1800.0	
1377	"	2000.0	
1378	"	2200.0	
1379	"	2400.0	
1380	"	2600.0	
1381	"	2800.0	
1382			Not used for this case
1383	UMW	5.0	Number of Mach number values in locations 1384-1389

1384	AMWD	0.0	Values of Mach number for the referred fuel flow table
1385	"	0.2	
1386	"	0.4	
1387	"	0.6	
1388	"	0.8	
1389			Not used for this case
1390	WDOT	0.150	Values of referred fuel flow corresponding to the referred temperature location 1375 and Mach numbers found in locations 1384-1388
1391	"	0.170	
1392	"	0.150	
1393	"	0.150	
1394	"	0.150	
1395			Not used for this case
1396	WDOT	0.277	Values of referred fuel flow corresponding to referred temp. location 1376 and Mach numbers found in locations 1384 - 1388
1397	"	0.277	
1398	"	0.277	
1399	"	0.277	
1400	"	0.277	
1401			Not used for this case
1402	WDOT	0.407	Values of referred fuel flow corresponding to referred temp. location 1377 and Mach numbers found in locations 1384 - 1388
1403	"	0.407	
1404	"	0.407	
1405	"	0.407	
1406	"	0.407	
1407			Not used for this case
1408	WDOT	0.535	Values of referred fuel flow corresponding to referred temperature location 1378 and Mach numbers found in locations 1384-1388
1409	"	0.535	
1410	"	0.535	
1411	"	0.535	
1412	"	0.535	
1413			Not used for this case
1414	WDOT	0.662	Values of referred fuel flow corresponding to referred temp. location 1379 and Mach numbers found in locations 1384 - 1388
1415	"	0.662	
1416	"	0.662	
1417	"	0.662	
1418	"	0.662	
1419			Not used for this case
1420	WDOT	0.750	Values of referred fuel flow corresponding to referred temp. location 1380 and Mach numbers
1421	"	0.750	
1422	"	0.750	

1423	"	0.750	found in locations 1384 - 1388
1424	"	0.750	
1425			Not used for this case
1426	WDOT	0.802	Values of referred fuel flow corresponding to referred temp. location 1381 and Mach numbers found in locations 1384 - 1388
1427	"	0.802	
1428	"	0.802	
1429	"	0.802	
1430	"	0.802	
1431 THRU 1437			Not used for this case
1438	UNT1	7.0	Number of referred temperatures in LOC 1439-1446
1439	TN1	1600.0	Values of referred turbine temp. for the referred gas generator RPM limit table
1440	"	1800.0	
1441	"	2000.0	
1442	"	2200.0	
1443	"	2400.0	
1444	"	2600.0	
1445	"	2800.0	
1446			Not used for this case
1447	UNM1	5.0	Number of Mach number values in locations 1448-1453
1448	AM1	0.0	Values of Mach number for the referred gas generator RPM limit table
1449	"	0.2	
1450	"	0.4	
1451	"	0.6	
1452	"	0.8	
1453			Not used for this case
1454	AONE	0.722	Referred gas generator RPM limit values corresponding to referred temp. location 1439 and Mach no. locations 1448-1452
1455	"	0.735	
1456	"	0.748	
1457	"	0.766	
1458	"	0.789	
1459			Not used for this case
1460	AONE	0.840	Values of referred fuel flow corresponding to referred temp. location 1376 and Mach numbers found in locations 1384 - 1388
1461	"	0.846	
1462	"	0.853	
1463	"	0.860	

1464	"	0.871	
1465			Not used for this case
1466	AONE	0.925	Referred gas generator RPM limit values corresponding to referred temp. location 1441 and Mach no. locations 1448-1452
1467	"	0.927	
1468	"	0.933	
1469	"	0.939	
1470	"	0.950	
1471			Not used for this case
1472	AONE	0.990	Referred gas generator RPM limit values corresponding to referred temp. location 1442 and Mach no. locations 1448-1452
1473	"	0.992	
1474	"	0.997	
1475	"	1.004	
1476	"	1.015	
1477			Not used for this case
1478	AONE	1.045	Referred gas generator RPM limit values corresponding to referred temp. location 1443 and Mach no. locations 1448-1452
1479	"	1.048	
1480	"	1.052	
1481	"	1.059	
1482	"	1.068	
1483			Not used for this case
1484	AONE	1.097	Referred gas generator RPM limit values corresponding to referred temp. location 1444 and Mach no. locations 1448-1452
1485	"	1.100	
1486	"	1.105	
1487	"	1.059	
1488	"	1.068	
1489			Not used for this case
1490	AONE	1.150	Referred gas generator RPM limit values corresponding to referred temp. location 1445 and Mach no. locations 1448-1452
1491	"	1.154	
1492	"	1.158	
1493	"	1.111	
1494	"	1.119	
1495 THRU 1501			Not used for this case
1502	UNT2	7.0	Number of referred temperatures in locations 1503-1510
1503	TN2	1600.0	Values of referred temperature for the referred power turbine
1504	"	1800.0	

1505	"	2000.0	speed limit ratio table
1506	"	2200.0	
1507	"	2400.0	
1508	"	2600.0	
1509	"	2800.0	
1510			Not used for this case
1511	UNM2	5.0	Number of Mach number values in locations 1512-1517
1512	AM2	0.0	Values of Mach number for the referred power turbine speed limit ratio table
1513	"	0.2	
1514	"	0.4	
1515	"	0.6	
1516	"	0.8	
1517			Not used for this case
1518	ATWO	0.445	Values of referred power turbine speed limit corresponding to referred temp. location 1503 and Mach no. locations 1512-1516
1519	"	0.461	
1520	"	0.500	
1521	"	0.557	
1522	"	0.640	
1523			Not used for this case
1524	ATWO	0.685	Values of referred power turbine speed limit corresponding to referred temp. location 1504 and Mach no. locations 1512-1516
1525	"	0.699	
1526	"	0.734	
1527	"	0.789	
1528	"	0.858	
1529			Not used for this case
1530	ATWO	0.856	Values of referred power turbine speed limit corresponding to referred temp. location 1505 and Mach no. locations 1512-1516
1531	"	0.880	
1532	"	0.908	
1533	"	0.940	
1534	"	0.973	
1535			Not used for this case
1536	ATWO	0.983	Values of referred power turbine speed limit corresponding to referred temp. location 1507 and Mach no. locations 1512-1516
1537	"	0.997	
1538	"	1.009	
1539	"	1.023	
1540	"	1.029	
1541			Not used for this case

1542	ATWO	1.084	Values of referred power turbine speed limit corresponding to referred temp. location 1507 and Mach no. locations 1512-1516
1543	"	1.088	
1544	"	1.089	
1545	"	1.086	
1546	"	1.076	
1547			Not used for this case
1548	ATWO	1.178	Values of referred power turbine speed limit corresponding to referred temp. location 1508 and Mach no. locations 1512-1516
1549	"	1.169	
1550	"	1.158	
1551	"	1.145	
1552	"	1.123	
1553			Not used for this case
1554	ATWO	1.264	Values of referred power turbine speed limit corresponding to referred temp. location 1509 and Mach no. locations 1512-1516
1555	"	1.246	
1556	"	1.224	
1557	"	1.197	
1558	"	1.161	
1559			Not used for this case

JJ. EXAMPLE DATA FILE

The remaining pages of this chapter are a presentation of the actual data file that was submitted on the MVS batch network at the NPS computer center for the tilt rotor aircraft described by the data above.

The user will note that the data above was kept in a sequential order for ease of reading. The data file, however, does not need to follow any sequence as can be seen in the sample file on pages 193-196.

```
//VASWAL03 JOB (1053,9999),'TOM WALSH SMC 2986',CLASS=C
//*MAIN ORG=NPGVM1.1053P
//GO  EXEC  PGM=VASII
//STEPLIB   DD  DSN=MSS.S1053.VASCOMP,DISP=SHR
//          DD  DSN=SYS1.PP.VFORTLIB,DISP=SHR
//FT06F001  DD  SYSOUT=A
//FT07F001  DD  SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=1300)
//GO.FT12F001 DD DSN=MSS.S1053.VIEWPLOT,DISP=(OLD,KEEP)
//FT05F001  DD  *
77777777
       8 PASSENGER TILT ROTOR
0001 5 1.0           0.0           0.0           1.0           3.0
0006 5 2.0           0.0           2.0           2.0           0.0
0011 4 0.0           0.0           0.0           13000.0
0015 5 0.0           0.0           0.0           0.0           0.0
0020 4 0.575         260.0         300.0         4.0
77777777
       AIRCRAFT DIMENSIONAL DATA
0101 1 6.6
0103 5 3.0           0.223         0.223         72.45         -6.5
0108 5 1.0           3.27          0.0           22.4          0.15
0114 3 1.0           50.25         0.08
0123 4 1.2           2.5           18.8            0.0
0129 3 2.33          23.2          0.09
0133 4 0.587         50.5          0.0            1.0
0139 4 0.0758        0.0           0.233          0.25
77777777
       PASSENGER DATA REQUIRED FOR FUSELAGE SIZING
0151 3 0.0           0.0           0.0
0159 4 1.0           1.0           8.0           2.0
0163 4 1.0           21.0          41.0          17.0
0167 2 0.0           0.0
77777777
       AIRCRAFT PROPULSION INFORMATION (TURBOSHAFT ENGINE)
0200 3 2.0           1.78          2920.0
0204 1 2.0
0206 5 0.95          0.0           1.098         0.0           1.0
0223 2 2.0           817.7
0226 5 25.0          0.123         72.92         3.0           0.25
0234 1 0.75
0257 3 0.0           1.0           15.0
77777777
       AIRCRAFT AERODYNAMICS INFORMATION
0305 1 0.0138
0307 2 9.08          2.0
0312 2 1.0           1.0
0317 2 0.0           4.0
0330 1 2000000.
```

```
0331 4 6.28          -1.0          0.3           0.35
0335 2 0.0           0.0
77777777
       ROTOR, PROPELLER, AND GEARBOX WEIGHT
0394 1 4.0
0396 4 61.0          0.12          44.0           2.2
0401 1 2477.0
0402 1 716.0
0403 5 0.0           15.67         0.016          0.0          165.0
0408 2 0.0162        0.779
0420 1 162.0
0422 5 0.04          0.80          1.0            0.6          350.0
0427 3 0.195         0.13          0.3422
0450 1 0.0
0453 1 345.0
0454 1 0.10
0456 3 0.1654        15.77         1.0
1201 5 1.0           0.0           0.0           2.0           0.0
1220 5 1.11          1.04          0.0           1.128         1.446
1223 1 0.905
1301 5 1.78          0.36          0.0           0.032         1650.0
1306 5 1800.0        2180.0        2235.0        2280.0        7.0
1311 5 1600.0        1800.0        2000.0        2200.0        2400.0
1316 2 2600.0        2800.0
1319 5 5.0           0.0           0.2           0.4           0.6
1324 1 0.8
1326 5 0.035         0.075         0.125         0.18          0.24
1332 5 0.33          0.375         0.425         0.48          0.534
1338 5 0.63          0.67          0.72          0.775         0.835
1344 5 0.92          0.96          1.01          1.065         1.125
1350 5 1.2           1.245         1.295         1.35          1.41
1356 5 1.34          1.39          1.44          1.495         1.55
1362 5 1.4           1.45          1.5           1.55          1.6
1374 5 7.0           1600.0        1800.0        2000.0        2200.0
1379 3 2400.0        2600.0        2800.0
1383 5 5.0           0.0           0.2           0.4           0.6
1388 1 0.8
1390 5 0.15          0.15          0.15          0.15          0.15
1396 5 0.278         0.278         0.278         0.278         0.278
1402 5 0.407         0.407         0.407         0.407         0.407
1408 5 0.535         0.535         0.535         0.535         0.535
1414 5 0.662         0.662         0.662         0.662         0.662
1420 5 0.750         0.750         0.750         0.750         0.750
1426 5 0.802         0.802         0.802         0.802         0.802
1438 5 7.0           1600.0        1800.0        2000.0        2200.0
1443 3 2400.0        2600.0        2800.0
1447 5 5.0           0.0           0.2           0.4           0.6
1452 1 0.8
```

```
1454 5 0.722         0.735         0.748         0.766         0.789
1460 5 0.84          0.846         0.853         0.86          0.871
1466 5 0.925         0.927         0.933         0.939         0.95
1472 5 0.99          0.992         0.997         1.004         1.015
1478 5 1.045         1.048         1.052         1.059         1.068
1484 5 1.097         1.1           1.105         1.111         1.119
1490 5 1.15          1.154         1.158         1.162         1.17
1502 5 7.0           1600.0        1800.0        2000.0        2200.0
1507 3 2400.0        2600.0        2800.0
1511 5 5.0           0.0           0.2           0.4           0.6
1516 1 0.8
1518 5 0.445         0.461         0.5           0.557         0.64
1524 5 0.685         0.699         0.734         0.789         0.858
1530 5 0.856         0.88          0.908         0.94          0.973
1536 5 0.983         0.997         1.009         1.023         1.029
1542 5 1.084         1.088         1.089         1.086         1.076
1548 5 1.178         1.169         1.158         1.145         1.123
1554 5 1.264         1.246         1.224         1.197         1.161
77777777
       MISSION FLIGHT PROFILE DATA
0027 5 1.0           2.0           3.0           4.0           5.0
0032 5 2.0           1.0           9.0           6.0           100.0
0501 2 0.0           0.0
0511 2 0.025         0.025
0541 2 0.81          0.81
0601 2 3.0           3.0
0611 2 0.0           0.0
0621 2 1.0           1.0
0661 2 0.01667       0.01667
0671 2 1.0           1.0
0681 2 0.01667       0.01667
0691 1 1.0
0711 1 0.0
0721 1 1000.0
0741 1 15000.0
0751 1 1.0
0761 1 20.0
0771 1 0.81
0801 1 1.0
0821 1 0.0
0831 1 20.0
0851 1 300.0
0861 1 2.0
0881 1 0.81
0901 1 1.0
0921 1 0.0
0931 1 -20.0
0951 1 1000.0
```

```
0961 1 300.0
0971 1 0.0
0981 1 0.81
1001 1 2.0
1011 1 0.1
1021 1 0.0
1031 1 0.3333
1061 1 0.81
1111 1 15000.
77777777
       MISCELLANEOUS
0094 1 1.0
0098 1 0.0
0100 1 1.0
88888888
99999999
/*
//
```

IV. V/STOL AIRCRAFT EXAMPLE

This chapter contains the output generated by running VASCOMP II using the data file shown at the end of Chapter III. The sequence of the results printed by the program using the standard format is as follows:

1. Data Echo
2. Size Data
3. Passenger Sizing Data
4. Weights Data
5. Propulsion Data
6. Aerodynamics Data
7. Mission Performance Data
8. Sizing and Performance Summary
9. Mission Data Summary

```
 DATE 11/25/85  8 PASSENGER TILT ROTOR                                 PAGE  1

                               V A S C O M P   I I

        V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

"LOC. " = LOCATION NUMBER GIVEN ON INPUT SHEET
"NUM " = NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX OF 5)
"VAL " = VALUE FOR VARIABLE CORRESPONDING TO LOC.
"VAL1" = VALUE FOR VARIABLE CORRESPONDING TO LOC.+0001
"VAL2" = VALUE FOR VARIABLE CORRESPONDING TO LOC.+0002
"VAL3" = VALUE FOR VARIABLE CORRESPONDING TO LOC.+0003
      ETC.

LOC. NUM      VAL           VAL1          VAL2          VAL3          VAL4

   1  5      1.000        0.0000E+00    0.0000E+00     1.000         3.000
   6  5      2.000        0.0000E+00     2.000         2.000        0.0000E+00
  11  4     0.0000E+00    0.0000E+00    0.0000E+00    0.1300E+05
  15  5     0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00
  20  4     0.5750         260.0         300.0         4.000

         AIRCRAFT DIMENSIONAL DATA
 101  1      6.600
 103  5      3.000        0.2230        0.2230         72.45        -6.500
 108  5      1.000         3.270        0.0000E+00     22.40        0.1500
 114  3      1.000         50.25        0.8000E-01
 123  4      1.200         2.500         18.80        0.0000E+00
 129  3      2.330         23.20        0.9000E-01
 133  4     0.5870         50.50        0.0000E+00     1.000
 139  4     0.7580E-01    0.0000E+00    0.2330        0.2500

         PASSENGER DATA REQUIRED FOR FUSELAGE SIZING
 151  3     0.0000E+00    0.0000E+00    0.0000E+00
 159  4      1.000         1.000         8.000         2.000
 163  4      1.000         21.00         41.00         17.00
 167  2     0.0000E+00    0.0000E+00

         AIRCRAFT PROPULSION INFORMATION (TURBOSHAFT ENGINE)
 200  3      2.000         1.780         2920.
 204  1      2.000
 206  5     0.9500        0.0000E+00     1.098        0.0000E+00     1.000
 223  2      2.000         817.7
 226  5     25.00         0.1230          72.92           3.000           0.2500
 234  1     0.7500
 257  3     0.0000E+00     1.000          15.00

          AIRCRAFT AERODYNAMICS INFORMATION
 305  1     0.1380E-01
 307  2      9.080         2.000
 312  2      1.000         1.000
 317  2     0.0000E+00     4.000
 330  1     0.2000E+07
 331  4      6.280        -1.000          0.3000          0.3500
 335  2     0.0000E+00    0.0000E+00

          ROTOR, PROPELLER, AND GEARBOX WEIGHT
 394  1      4.000
 396  4      61.00        0.1200           44.00           2.200
 401  1      2477.
 402  1      716.0
 403  5     0.0000E+00     15.67          0.1600E-01      0.0000E+00       165.0
 408  2     0.1620E-01    0.7790
 420  1      162.0
 422  5     0.4000E-01    0.8000           1.000          0.6000           350.0
 427  3     0.1950        0.1300          0.3422
 450  1     0.0000E+00
 453  1      345.0
 454  1     0.1000
 456  3     0.1654         15.77           1.000
1201  5      1.000        0.0000E+00      0.0000E+00       2.000          0.0000E+00
1220  5      1.110         1.040          0.0000E+00       1.128           1.446
1223  1     0.9050
1301  5      1.780        0.3600          0.0000E+00      0.3200E-01       1650.
1306  5      1800.         2180.           2235.           2280.           7.000
1311  5      1600.         1800.           2000.           2200.           2400.
1316  2      2600.         2800.
1319  5      5.000        0.0000E+00      0.2000          0.4000          0.6000
1324  1     0.8000
1326  5     0.3500E-01    0.7500E-01      0.1250          0.1800          0.2400
1332  5     0.3300        0.3750          0.4250          0.4800          0.5340
1338  5     0.6300        0.6700          0.7200          0.7750          0.8350
1344  5     0.9200        0.9600           1.010           1.065           1.125
1350  5      1.200         1.245           1.295           1.350           1.410
1356  5      1.340         1.390           1.440           1.495           1.550
1362  5      1.400         1.450           1.500           1.550           1.600
1374  5      7.000         1600.           1800.           2000.           2200.
1379  3      2400.         2600.           2800.
1383  5      5.000        0.0000E+00      0.2000          0.4000          0.6000
1388  1     0.8000
1390  5     0.1500        0.1500          0.1500          0.1500          0.1500
```

```
1396  5      0.2780       0.2780       0.2780       0.2780       0.2780
1402  5      0.4070       0.4070       0.4070       0.4070       0.4070
1408  5      0.5350       0.5350       0.5350       0.5350       0.5350
1414  5      0.6620       0.6620       0.6620       0.6620       0.6620
1420  5      0.7500       0.7500       0.7500       0.7500       0.7500
1426  5      0.8020       0.8020       0.8020       0.8020       0.8020
1438  5       7.000        1600.        1800.        2000.        2200.
1443  3       2400.        2600.        2800.
1447  5       5.000       0.0000E+00   0.2000       0.4000       0.6000
1452  1      0.8000
1454  5      0.7220       0.7350       0.7480       0.7660       0.7890
1460  5      0.8400       0.8460       0.8530       0.8600       0.8710
1466  5      0.9250       0.9270       0.9330       0.9390       0.9500
1472  5      0.9900       0.9920       0.9970        1.004        1.015
1478  5       1.045        1.048        1.052        1.059        1.068
1484  5       1.097        1.100        1.105        1.111        1.119
1490  5       1.150        1.154        1.158        1.162        1.170
1502  5       7.000        1600.        1800.        2000.        2200.
1507  3       2400.        2600.        2800.
1511  5       5.000       0.0000E+00   0.2000       0.4000       0.6000
1516  1      0.8000
1518  5      0.4450       0.4610       0.5000       0.5570       0.6400
1524  5      0.6850       0.6990       0.7340       0.7890       0.8580
1530  5      0.8560       0.8800       0.9080       0.9400       0.9730
1536  5      0.9830       0.9970        1.009        1.023        1.029
1542  5       1.084        1.088        1.089        1.086        1.076
1548  5       1.178        1.169        1.158        1.145        1.123
1554  5       1.264        1.246        1.224        1.197        1.161

           MISSION FLIGHT PROFILE DATA
  27  5       1.000        2.000        3.000        4.000        5.000
  32  5       2.000        1.000        9.000        6.000        100.0
 501  2      0.0000E+00   0.0000E+00
 511  2      0.2500E-01   0.2500E-01
 541  2      0.8100       0.8100
 601  2       3.000        3.000
 611  2      0.0000E+00   0.0000E+00
 621  2       1.000        1.000
 661  2      0.1667E-01   0.1667E-01
 671  2       1.000        1.000
 681  2      0.1667E-01   0.1667E-01
 691  1       1.000
 711  1      0.0000E+00
 721  1       1000.
 741  1      0.1500E+05
 751  1       1.000
 761  1       20.00
 771  1      0.8100
 801   1       1.000
 821   1      0.0000E+00
 831   1       20.00
 851   1       300.0
 861   1       2.000
 881   1      0.8100
 901   1       1.000
 921   1      0.0000E+00
 931   1      -20.00
 951   1       1000.
 961   1       300.0
 971   1      0.0000E+00
 981   1      0.8100
1001   1       2.000
1011   1      0.1000
1021   1      0.0000E+00
1031   1      0.3333
1061   1      0.8100
1111   1      0.1500E+05

            MISCELLANEOUS
  94   1       1.000
  98   1      0.0000E+00
 100   1       1.000
```

```
DATE 11/25/85  8 PASSENGER TILT ROTOR                              PAGE  2

                              V A S C O M P  II

          V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

S I Z E  D A T A  THIS RUN CONVERGED IN  2 ITERATION(S)

                            GROSS WEIGHT =  13155.  LB

    FUSELAGE
       LF             LENGTH                                  37.0     FT
       WF             WIDTH                                    6.8     FT
       SF             WETTED AREA                             632.     SQFT
    WING
       AR             ASPECT RATIO                            6.60
       SW             AREA                                   181.6     SQFT
       B              SPAN                                    34.6     FT
       CBARW          GEOM. MEAN CHORD                         5.2     FT
       LAMBDA C       QUARTER CHORD SWEEP                     -6.5     DEG
       LAMBDA         TAPER RATIO                            1.000
       (T/C)R         ROOT  THICKNESS                        0.223
       (T/C)T         TIP  THICKNESS                         0.223
       WG/SW          WING LOADING                            72.4     LB/SQFT
       C BAR / D      MEAN CHORD / PROP. DIA.                0.210
    HOR. TAIL
       ARHT           ASPECT RATIO                            3.27
       SHT            AREA                                    50.3     SQFT
       BHT            SPAN                                    12.8     FT
       CBARHT         MEAN CHORD                               3.9     FT
       (T/C)HT        THICKNESS / CHORD                      0.150
       ELTH           MOMENT ARM                              22.4     FT
       VBARH          VOLUME COEF.                           1.182
    VERT. TAIL
       ARVT           ASPECT RATIO                            2.33
       SVT            AREA                                    50.5     SQFT
       BVT            SPAN                                    10.8     FT
       CBARVT         MEAN CHORD                               4.8     FT
       (T/C)VT        THICKNESS / CHORD                      0.090
       ELTV           MOMENT ARM                              23.2     FT
       VBARV          VOLUME COEF.                           0.186
    PRIMARY ENG. NACELLE
       LN             LENGTH                                   8.9     FT
       DBARN          MEAN DIAMETER                            2.9     FT
       SN             WETTED AREA                            162.0     SQFT
    LIFT ENG. NACELLE
                      NO LIFT PROPULSION SELECTED
```

```
PROPELLER
    D              DIAMETER                              25.0     FT
    SIGMA R/P      SOLIDITY                             0.092
    WG/A           DISC LOADING                          13.4     LB/SQFT
    CT/SIGMA       THRUST COEFF. / SOLIDITY             0.123
    NR             NO. OF PROPELLERS                    2.000
    NO. BLADES     NO. OF BLADES/PROP                   3.000
    SR             BLADE CUTOUT / RADIUS RATIO          0.080
    VT             TIPSPEED                             817.7     FT/SEC
```

```
DATE 11/25/85   8 PASSENGER TILT ROTOR                                    PAGE  3

                                   V A S C O M P   II

           V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM     B-93

P A S S E N G E R   S I Z I N G   D A T A

                        TOURIST                 FIRST CLASS
                        -------                 -----------
          NO.  OF PASS.      8.                      0.
          NO.  ABREAST       2.                      0.
          NO. OF AISLES      1.                      0.
          UNIT SEAT WIDTH   21.  IN.                 0.  IN.
          SEAT PITCH        41.  IN.                 0.  IN.
          AISLE WIDTH       17.  IN.                 0.  IN.

          NUMBER OF LAVATORIES        1.00
          GALLEY AREA                 2.2  SQ.  FT.
          CLOSET AREA                 0.6  SQ.  FT.
          CABIN DIAMETER             76.4  IN.         *** TOURIST CLASS CRITICAL
          BODY DIAMETER              81.3  IN.         *** TOURIST CLASS CRITICAL

          NOSE SECTION LENGTH         8.1  FT.
          TAIL SECTION LENGTH        16.9  FT.
          CONST.  DIA.  LENGTH       11.9  FT.

            TOTAL FUSELAGE LENGTH        37.0 FT.
```

```
DATE 11/25/85  8 PASSENGER TILT ROTOR                                  PAGE  4

                                  V A S C O M P  II

          V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

W E I G H T S  D A T A    IN LBS

          EMLF           MANEUVER LOAD FACTOR                    4.000
          GLF            GUST LOAD     FACTOR                    2.615
          ULF            ULTIMATE LOAD FACTOR                    6.000

      STRUCTURES GROUP
          K8  WW         WING                                     904.
          K9  WHT        HOR. TAIL                                135.
          K10 WVT        VERT. TAIL                                99.
          K11 WB         FUSELAGE                                1494.
          K12 WLG        LANDING GEAR                             526.
          K13 WLES       LIFT ENGINE SECTION                        0.
          K14 WPES       PRIMARY ENGINE SECTION                   360.
          SPACE5(2)      PRIMARY ENGINE ACOUSTIC TREAT.             0.
          DELTA WST      STRUCTURE WEIGHT INCREMENT                 0.
          WST            TOTAL STRUCTURE WEIGHT                  3519.
      PROPULSION GROUP
          K2  WR/P       ROTOR OR PROP                            894.
          K3  WDS        DRIVE SYSTEM                            1385.
          K4  WEL        LIFT ENGINES                               0.
          K5  WEP        PRIMARY ENGINES                         1051.
          K6  WLEI       LIFT ENGINE INSTALLATION                   0.
          K7  WPEI       PRIMARY ENGINE INSTALLATION              174.
          K21 WFS        FUEL SYSTEM                              146.
          DELTA WP       PROPULSION GROUP WEIGHT INCREMENT          0.
          WP             TOTAL PROPULSION GROUP WEIGHT           3650.

      FLIGHT CONTROLS GROUP
          K15 WCC        COCKPIT CONTROLS                          45.
          K16 WUC        UPPER   CONTROLS                         696.
          K17 WH         HYDRAULICS                                 0.
          K18 WFW        FIXED WING CONTROLS                      210.
          K19 WSAS       SAS                                      165.
          K20 WTM        TILT MECHANISM                           213.
          DELTA WFC      CONTROL WEIGHT INCREMENT                   0.
          WFC            TOTAL CONTROL WEIGHT                    1330.
```

WFE	WEIGHT OF FIXED EQUIPMENT	2477.
WE	WEIGHT EMPTY	10976.
WFUL	FIXED USEFUL LOAD	716.
OWE	OPERATING WEIGHT EMPTY	11692.
WPL	PAYLOAD	0.
(WF)A (WF)W	FUEL	1463. 1463.
WG	GROSS WEIGHT	13155.

```
DATE 11/25/85  8 PASSENGER TILT ROTOR                                    PAGE  5

                                   V A S C O M P  II
          V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
P R O P U L S I O N  D A T A
    PRIMARY PROPULSION CYCLE NO.    1.780
          TURBOSHAFT ENGINE
           2.   ENGINES
          BHP*P  MAX.  STANDARD S.L.  STATIC H.P.     2920.  H.P.
          POWER LOADING = 0.2220
          ENGINE SIZE WAS FIXED BY INPUT

    ACCESSORY HORSEPOWER EXTRACTED =   15.00  H.P.

    NO LIFT ENGINE CYCLE SELECTED
    XMSN SIZED AT 100.  PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
    (MAX.STANDARD S.L.  STATIC H.P.),100.0 PERCENT HOVER RPM

    TRANSMISSION EFFICIENCY = 0.9500
```

```
 DATE 11/25/85  8 PASSENGER TILT ROTOR                                  PAGE  6

                               V A S C O M P  II

         V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

A E R O D Y N A M I C S  D A T A
         FE             TOTAL EFFECTIVE FLATPLATE AREA         9.204  SQFT
         SWET           TOTAL WETTED AREA                      1324.  SQFT
         CBARF          MEAN SKIN FRICTION COEFF.           0.006954

D R A G  B R E A K D O W N        IN  SQFT
         FEW            WING FE                                0.000
         FEF            FUSELAGE FE                            6.698
         FEVT           VERT.  TAIL FE                         0.000
         FEHT           HOR.   TAIL FE                         0.000
         FEN            PRIMARY ENG. NACELLE FE                0.000
         FELN           LIFT ENG. NACELLE FE                   0.000
         DELTA FE       INCREMENTAL FE                         2.506

A E R O D Y N A M I C  C O E F F .
         A1                                                  0.59515
         A2                                                 -0.11302
         A3                                                  0.12091
         A4                                                  0.16725
         A5                                                  0.05069
         A6                                                  0.99232
         A7                                                  0.07202
         CL ALPHA       3-D LIFT SLOPE                       5.11200 PER RADIAN
         E              OSWALD   FACTOR                         0.66967
```

```
DATE 11/25/85  8 PASSENGER TILT ROTOR                                          PAGE  7

                                   V A S C O M P  II
                 V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
                        M I S S I O N  P E R F O R M A N C E  D A T A

TAXI FOR 0.025 HRS AT GROUND IDLE ENGINE RATING; TEMPERATURE =  59.0 DEG.F

                FUEL             PRES         TURB ENG  PETF
TIME    RNG    USED   WEIGHT     ALT    TAS   TEMP CODE  OR   LETF
(HRS)  (NM)   (LB)    (LB)      (FT)   (KT)  (R)        PEHF
0.000    0.0     0.  13155.        0.     0.  1650.  T   0.091 0.000
0.025    0.0    13.  13142.        0.     0.  1650.  T   0.091 0.000

TAKEOFF, HOVER, OR LAND AT PETF = 1.000  LETF = 0.000 FOR  0.017 HRS.
VERTICAL RATE OF CLIMB =    0.0 FT/MIN                 TEMPERATURE =  59.0 DEG.F

                FUEL             PRES         TURB ENG  PETF         THRUST
TIME    RNG    USED   WEIGHT     ALT    TAS   TEMP CODE  OR   LETF    TO     FM      CT
(HRS)  (NM)   (LB)    (LB)      (FT)   (KT)  (R)        PEHF        WEIGHT
0.025    0.0    13.  13142.        0.     0.  2241.  T   1.000 0.000 1.281  0.644 0.1021
0.042    0.0    41.  13114.        0.     0.  2241.  T   1.000 0.000 1.283  0.644 0.1021

CLIMB  TO 15000.  FT. WITH   MAXIMUM R/C  AT MILITARY  ENGINE RATING

                FUEL             PRES         TURB ENG  PETF                 MACH        THETA
TIME   RNG     USED   WEIGHT     ALT    TAS   TEMP CODE  OR    EAS    MACH  DIV    R/C     F
(HRS) (NM)    (LB)    (LB)      (FT)   (KT)  (R)        PEHF                      (FPM)(DEG)
0.042    0.0    41.  13114.        0.  159.  2235.  T   0.944 159.2 .241 .503 4148.  20.0
0.046    0.6    47.  13108.     1000.  159.  2235.  T   0.947 156.8 .241 .500 4064.  20.0
0.050    1.3    54.  13101.     2000.  159.  2235.  T   0.950 154.2 .242 .497 3971.  20.0
0.054    1.9    60.  13095.     3000.  158.  2235.  T   0.953 151.6 .242 .493 3867.  20.0
0.058    2.6    67.  13088.     4000.  158.  2235.  T   0.956 148.9 .242 .489 3754.  20.0
0.063    3.2    74.  13081.     5000.  157.  2235.  T   0.959 146.2 .242 .485 3630.  20.0
0.067    3.9    80.  13075.     6000.  157.  2235.  T   0.961 143.4 .242 .481 3496.  20.0
0.072    4.7    87.  13068.     7000.  156.  2235.  T   0.964 140.5 .242 .476 3351.  20.0
0.077    5.4    94.  13061.     8000.  155.  2235.  T   0.968 137.7 .241 .471 3194.  20.0
0.082    6.2   101.  13054.     9000.  154.  2235.  T   0.972 134.7 .241 .465 3027.  20.0
0.088    7.1   108.  13047.    10000.  153.  2235.  T   0.975 131.8 .240 .459 2848.  20.0
0.094    7.9   116.  13039.    11000.  151.  2235.  T   0.977 128.1 .238 .451 2588.  20.0
0.100    8.9   124.  13031.    12000.  153.  2235.  T   0.978 127.8 .242 .450 2292.  18.9
0.107   10.0   133.  13022.    13000.  155.  2235.  T   0.980 127.4 .246 .449 2126.  18.2
0.115   11.2   142.  13013.    14000.  158.  2235.  T   0.981 127.0 .250 .448 1959.  17.6
0.124   12.6   152.  13003.    15000.  160.  2235.  T   0.983 126.7 .255 .447 1791.  17.0
```

```
CRUISE AT   NORMAL   ENGINE RATING         TEMPERATURE =   5.5 DEG.F

                FUEL         PRES         TURB ENG PETF             MACH SPEC   ETAP
TIME   RNG      USED  WEIGHT  ALT    TAS  TEMP CDE  OR    EAS   MACH DIV  RANGE  PROP
(HRS) (NM)     (LB)   (LB)   (FT)  (KT) (R)        PEHF                 (NMPP)
0.124  12.6   152. 13003. 15000. 270. 2180. T  0.956 214.1 .431 .543 .25512 .865
0.151  20.0   181. 12974. 15000. 270. 2180. T  0.956 214.2 .431 .543 .25524 .865
0.225  40.0   259. 12896. 15000. 270. 2180. T  0.956 214.5 .431 .544 .25556 .864
0.299  60.0   338. 12818. 15000. 271. 2180. T  0.956 214.7 .432 .544 .25588 .864
0.373  80.0   416. 12739. 15000. 271. 2180. T  0.956 215.0 .432 .545 .25620 .864
0.447 100.0   494. 12661. 15000. 271. 2180. T  0.956 215.2 .433 .545 .25651 .864
0.521 120.0   572. 12583. 15000. 272. 2180. T  0.956 215.5 .434 .545 .25682 .864
0.594 140.0   650. 12505. 15000. 272. 2180. T  0.956 215.8 .434 .546 .25712 .863
0.668 160.0   727. 12428. 15000. 272. 2180. T  0.956 216.0 .435 .546 .25742 .863
0.741 180.0   805. 12350. 15000. 273. 2180. T  0.956 216.3 .435 .547 .25771 .863
0.815 200.0   883. 12272. 15000. 273. 2180. T  0.956 216.5 .436 .547 .25801 .863
0.888 220.0   960. 12195. 15000. 273. 2180. T  0.956 216.7 .436 .547 .25830 .863
0.961 240.0 1038. 12117. 15000. 274. 2180. T  0.956 217.0 .437 .548 .25858 .862
1.034 260.0 1115. 12040. 15000. 274. 2180. T  0.956 217.2 .437 .548 .25886 .862
1.091 275.6 1175. 11980. 15000. 274. 2180. T  0.956 217.4 .437 .549 .25908 .862

DESCEND TO H =     0. FT.  ,R =   300.00 N.MI. AT MAX. SPEED

                FUEL         PRES         TURB ENG   PETF               MACH         THETA
TIME   RNG      USED  WEIGHT  ALT    TAS  TEMP CODE   OR    EAS   MACH DIV   R/S      F
(HRS) (NM)     (LB)   (LB)   (FT)  (KT) (R)          PEHF                  (FPM)  (DEG)
1.091 275.6 1175. 11980. 15000. 328. 1800. T    0.572 260.0 .523 .563 4166.  -8.0
1.095 276.9 1178. 11977. 14000. 322. 1800. T    0.560 260.0 .513 .563 3505.  -6.9
1.100 278.4 1181. 11974. 13000. 317. 1800. T    0.549 260.0 .503 .563 3408.  -6.9
1.105 280.0 1184. 11971. 12000. 312. 1800. T    0.537 260.0 .493 .563 3314.  -6.8
1.110 281.6 1188. 11967. 11000. 307. 1800. T    0.526 260.0 .483 .563 3222.  -6.7
1.115 283.1 1191. 11964. 10000. 303. 1800. T    0.515 260.0 .474 .563 3132.  -6.7
1.120 284.7 1195. 11960.  9000. 298. 1800. T    0.504 260.0 .465 .563 3045.  -6.6
1.126 286.4 1199. 11956.  8000. 293. 1800. T    0.492 260.0 .456 .563 2962.  -6.5
1.132 288.0 1203. 11952.  7000. 289. 1800. T    0.481 260.0 .447 .563 2882.  -6.4
1.137 289.7 1207. 11948.  6000. 284. 1800. T    0.471 260.0 .439 .563 2805.  -6.4
1.143 291.3 1212. 11943.  5000. 280. 1800. T    0.461 260.0 .431 .563 2733.  -6.3
1.149 293.0 1216. 11939.  4000. 276. 1800. T    0.450 260.0 .423 .563 2666.  -6.3
1.156 294.8 1221. 11934.  3000. 272. 1800. T    0.440 260.0 .415 .563 2604.  -6.2
1.162 296.5 1226. 11929.  2000. 268. 1800. T    0.429 260.0 .407 .563 2547.  -6.2
1.169 298.2 1231. 11924.  1000. 264. 1800. T    0.418 260.0 .400 .563 2496.  -6.2
1.175 300.0 1237. 11918.     0. 260. 1800. T    0.407 260.0 .393 .563 2450.  -6.1
```

```
TAKEOFF, HOVER, OR LAND AT PETF = 1.000  LETF = 0.000 FOR  0.017 HRS.
VERTICAL RATE OF CLIMB =    0.0 FT/MIN              TEMPERATURE =  59.0 DEG.F

              FUEL              PRES          TURB ENG  PETF          THRUST
TIME    RNG   USED    WEIGHT    ALT     TAS   TEMP CODE  OR     LETF    TO     FM     CT
(HRS)   (NM)  (LB)     (LB)     (FT)    (KT)  (R)       PEHF          WEIGHT
1.175 300.0 1237.  11918.        0.      0.  2241.  T   1.000 0.000 1.412 0.644 0.1021
1.192 300.0 1264.  11891.        0.      0.  2241.  T   1.000 0.000 1.416 0.644 0.1021

TAXI FOR 0.025 HRS AT GROUND IDLE ENGINE RATING; TEMPERATURE =  59.0 DEG.F

              FUEL              PRES          TURB ENG  PETF
TIME    RNG   USED    WEIGHT    ALT     TAS   TEMP CODE  OR     LETF
(HRS)   (NM)  (LB)     (LB)     (FT)    (KT)  (R)       PEHF
1.192 300.0 1264.  11891.        0.      0.  1650.  T   0.091 0.000
1.217 300.0 1278.  11877.        0.      0.  1650.  T   0.091 0.000

      TRANSFER ALTITUDE TO   15000. FT.

                                FUEL                   PRES.
       TIME       RANGE         USED        WEIGHT      ALT.
       (HRS)      (N.M.)        (LBS)       (LBS.)      (FT)
       1.217       300.00       1277.6       11877.          0.
       1.217       300.00       1277.6       11877.      15000.

LOITER FOR  0.333 HRS. FOR RESERVE FUEL     TEMPERATURE=    5.5 DEG.F

              FUEL              PRES          TURB ENG PETF                 MACH  FUEL   ETAP
TIME  RNG     USED    WEIGHT    ALT     TAS   TEMP CDE  OR     EAS   MACH   DIV   RATE   PROP
(HRS) (NM)    (LB)     (LB)     (FT)    (KT)  (R)      PEHF                      (LB-HR)
1.217 300.0 1278.  11877. 15000. 146.  1748.  P  0.489 116.1 .233 .433    584.  .849
1.317 300.0 1336.  11819. 15000. 145.  1745.  P  0.486 115.3 .232 .432    581.  .848
1.417 300.0 1394.  11761. 15000. 145.  1743.  P  0.483 115.3 .232 .433    578.  .847
1.517 300.0 1452.  11703. 15000. 145.  1741.  P  0.480 115.3 .232 .433    576.  .847
1.550 300.0 1471.  11684. 15000. 145.  1740.  P  0.479 115.3 .232 .434    575.  .846

              MISSION FUEL REQUIRED =  1277.57
              RESERVE FUEL REQUIRED =   193.49
              TOTAL   FUEL REQUIRED =  1471.06

********************************************************************************

                        END   OF   SUCCESSFUL   CASE

********************************************************************************
```

```
DATE 11/25/85  8 PASSENGER TILT ROTOR                                    PAGE  1

                              V A S C O M P  II

          V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93
                                  S U M M A R Y
                                            ITERATION NO.  =   2

GROSS WEIGHT        =    13155.                WING AREA            =    181.58
NO.PRIMARY ENGINES  =       2.                 WING LOADING         =     72.45
PRIMARY THR.OR.PWR  =     2920.                SPAN                 =     34.62
PRIM. T/W OR BHP/W  =    0.2220                ASPECT RATIO         =      6.60
1ST CLASS PASS.     =       0.                 1/4 CHORD SWEEP      =     -6.50
TOURIST PASS.       =       8.                 TAPER RATIO          =    1.0000
FUSELAGE LENGTH     =     36.99                FUSELAGE WIDTH       =      6.78
HORIZ. TAIL AREA    =      50.                 VERT. TAIL AREA      =       51.
EMPTY WEIGHT        =    10976.                OPER.WEIGHT EMPTY    =    11692.
PAYLOAD WEIGHT      =       0.                 WEIGHT OF FUEL       =     1463.
TOTAL WETTED AREA   =     1324.                EFF.FLAT PL. AREA    =     9.204
MEAN S.F. COEFF.    =   0.00695                NO.OF LIFT ENGINES   =        0.
LIFT ENG. THRUST    =       0.                 LIFT THRUST/GRS WT   =    0.0000
```

```
                         M I S S I O N   D A T A

                      SEG.      SEG.                SEG.
                      TIME      FUEL      ALT.      DIST
                     (MIN)     (LBS)      (FT)     (NMI)

         TAXI          1.5      13.3       0.0
         TOFF/LND      1.0      27.5       0.0
         CLIMB         4.9     111.0                12.6
         CRUISE       58.1    1023.6   15000.0     263.1     MACH NO.  =0.437
         DESCENT       5.0      61.5                24.4
         TOFF/LND      1.0      27.5       0.0
         TAXI          1.5      13.3       0.0

RNG= 300.NM MSN.FUEL= 1278.  RSRV.FUEL=  193.  TOT.FUEL= 1471.  BLOCK TIME=  73.
```

LIST OF REFERENCES

1. NASA CR 2544, *Conceptual Design Study of 1985 Commercial Tilt Rotor Transports*, by Bell Helicopter Company, p. 7, May 1975

2. NASA CR 151987, *Applications of Advanced V/STOL Aircraft Concepts to Civil Utility Missions*, by The Aerospace Corp., v. 2, pp. 25-144, February 1977.

3. Boeing VERTOL Company, Report D8-0375, *User´s Manual for VASCOMP II, The V/STOL Aircraft Sizing and Performance Computer Program*, Volume VI, Third Revision, by A. H. Schoen et al, May 1980.

4. Boeing VERTOL Company, US Navy Contract N62269-79-C-0217, *User´s Manual for HESCOMP, The Helicopter Sizing and Performance Computer Program*, Second Revision, by S. J. Davis et al, October 1979.

5. Zuk, J., "Civil Benefits of the JVX", *Vertiflite*, v. 30, No. 1, pp. 20-23, Jan/Feb 1984.

6. *Jane´s All The World´s Aircraft 1971-72*, pp. 262-264, Sampson, Low, Marstol & Co. Ltd., 1971.

7. Martin, S. and Peck, W. B., *JVX Design Update*, paper presented at the 40th Annual Forum of the American Helicopter Society, Arlington, Virginia, May 16-18, 1984.

BIBLIOGRAPHY

"Advanced VTOL Concepts to be Studied," Aviation Week & Space Technology, April 30, 1973, pp. 85-86.

"Bell Tilt-Rotor: The Next V/STOL?" Flight International, February 9, 1980, pp. 381-386, 412.

"Bell XV-15 to Test Tilt-Rotor Concept," Aviation Week & Space Technology, November 1, 1976, pp. 20-21.

"Development of V/STOL Aircraft 1950 to 1970," Journal of the American Helicopter Society, June 1979, pp. 7-16.

"Flexibility is Offered by XV-15 Tilt-Rotor Concept," Aviation Week & Space Technology, January 11, 1982, pp. 74- 76, 81, 83, 85.

"Flying the V-22 Predecessor: The NASA/Army/Bell XV-15," Rotor & Wing International, June 1985, pp. 44-50, 54-58, 93.

"Handling Qualities Evaluation of the XV-15 Tilt Rotor Aircraft," Journal of the American Helicopter Society, April 1975, pp. 23-33.

"Improving the Helicopter - What Next?" Interavia, October 1972, pp. 1121-1123.

"Joint Services Vertical Lift Development (JVX) Program: Looking to the Future," Vertiflite, Nov/Dec 1984, pp. 24-25.

"JVX: Entering Preliminary Design," Vertiflite, Nov/Dec 1983, pp. 18-19.

"JVX: The World's First Production Tilt-Rotor?" Interavia, July 1983, pp. 755-757.

"JVX: Tilt-Rotor Sets Out to Succeed," Flight International, November 5, 1983, pp. 1214-1216.

"JVX Program: Still a lot of Questions," Interavia, April 1983, pp. 348-349.

"Military Potential of the Tilt-Rotor Aircraft," Aeronautical Journal, March 1983, pp. 99-103.

"Moving V/STOL from Technology to System," Astronautics and Aeronautics, December 1977, pp. 26-27.

"Proposal Request for JVX Authorized for December," Aviation Week & Space Technology, November 22, 1982, pg 29.

"Structural Components, Design of Tilt-Rotor JVX Near Completion," Aviation Week & Space Technology, January 14, 1985, pp. 84-87.

"The Promise of Tilt-Rotor," Aircraft Engineering, July 1978, pp. 11-13.

"The XV-15 Experience From Wind Tunnel and Simulations to Joint Services V/STOL Aircraft," Presented at Army Operations Research Symposium, Fort Eustis, Virginia, October 4-5, 1983.

"The XV-15 Tilt Rotor Research Aircraft," Society of Experimental Test Pilots Symposium Proceedings, Sept. 1980, pp. 168-185.

"Tilt-Rotor Aircraft," Army Research, Development and Acquisition Magazine, May-June 1980, pp 1-3.

"Tilt-Rotor Aircraft Nears Final Design," Aviation Week & Space Technology, May 20, 1974, pp. 51-53.

"Tilt-Rotor: Expanding Rotorcraft Horizons," Vertiflite, May/June 1980, pp. 8-11.

"Tilt-Rotor VTOL," Popular Science, February 1978, pp. 68-70.

"V/STOL - Turning Promise to Reality," Astronautics and Aeronautics, September 1965.

"XV-15 Experience: Joint Service Operational Testing of an Experimental Aircraft," Society of Experimental Test Pilots Symposium Proceedings, September 1983, pp. 4-20.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Library, Code 0142 Naval Postgraduate School Monterey, California 93943-5002	2
3.	Department Chairman, Code 67 Department of Aeronautics Naval Postgraduate School Monterey, California 93943-5000	5
4.	Professor Donald M. Layton, Code 67Ln Department of Aeronautics Naval Postgraduate School Monterey, California 93943-5000	1
5.	Captain Thomas P. Walsh US Army Avaition Engineering Flight Activity Engineering Flight Test Division A Edwards Air Force Base, California 93523-5000	1

217627

Thesis
W222936
c.1

Walsh
A trade-off study of tilt rotor aircraft versus helicopters using VASCOMP II and HESCOMP.

DUDLEY KNOX LIBRARY
3 2768 00018049 1